

INDUSTRIAL
DIESEL ENGINE

3LA1, 3LB1, 3LD1
MODELS

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MODELS

WORKSHOP MANUAL

ISUZU MOTORS LIMITED

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FOREWORD

This Workshop Manual is designed to help you perform necessary maintenance, service, and repair procedures on applicable Isuzu industrial engines.

Information contained in this Workshop Manual is the latest available at the time of publication.

Isuzu reserves the right to make changes at any time without prior notice.

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SECTION 1

GENERAL INFORMATION

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GENERAL REPAIR INSTRUCTIONS

1. Before performing any service operation with the engine mounted, disconnect the grounding cable from the battery.
This will reduce the chance of cable damage and burning due to short circuiting.
2. Always use the proper tool or tools for the job at hand.
Where specified, use the specially designed tool or tools.
3. Use genuine ISUZU parts referring ISUZU PARTS CATALOG for the engines.
4. Never reuse cotter pins, gaskets, O-rings, lock washers, and self locking nuts. Discard them as you remove them. Replace them with new ones.
5. Always keep disassembled parts neatly in groups. This will ensure a smooth reassembly operation.
It is especially important to keep fastening parts separate. These parts vary in hardness and design, depending on their installation position.
6. All parts should be carefully cleaned before inspection or reassembly.
Oil ports and other openings should be cleaned with compressed air to make sure that they are completely free of obstructions.
7. Rotating and sliding part surfaces should be lubricated with oil or grease before reassembly.
8. If necessary, use a sealer on gaskets to prevent leakage.
9. Nut and bolt torque specifications should be carefully followed.
10. Always release the air pressure from any machine-mounted air tank(s) before dismounting the engine or disconnecting pipes and hoses.
11. Always check and recheck your work. No service operation is complete until you have done this.
12. Information contained in the "Main Data and Specifications" of the Workshop Manual and the Instruction Book may differ. In this case, the information contained in the Instruction Book should be considered applicable.

NOTES ON THE FORMAT OF THIS MANUAL

This Workshop Manual is applicable to the 3LA1, 3LB1, 3LD1 family of industrial diesel engines. Unless otherwise specified, these engines have common parts and components as well as data and specifications.

Illustrations used in this Workshop Manual are based on the 3LB1 and 3LD1 engines.

1. Find the applicable section by referring to the Table of Contents at the beginning of the Manual.
2. Common technical data such as general maintenance items, service specifications, and tightening torques are included in the "General Information" section.
3. Each section is divided into sub-sections dealing with disassembly, inspection and repair, and reassembly.
4. When the same servicing operation is applicable to several different units, the manual will direct you to the appropriate page.
5. For the sake of brevity, self-explanatory removal and installation procedures are omitted.
More complex procedures are covered in detail.

6. Each service operation section in this Workshop Manual begins with an exploded view of the applicable area.

(Example)

Major components

Figures in parentheses “()” show the order of disassembling or reassembling.

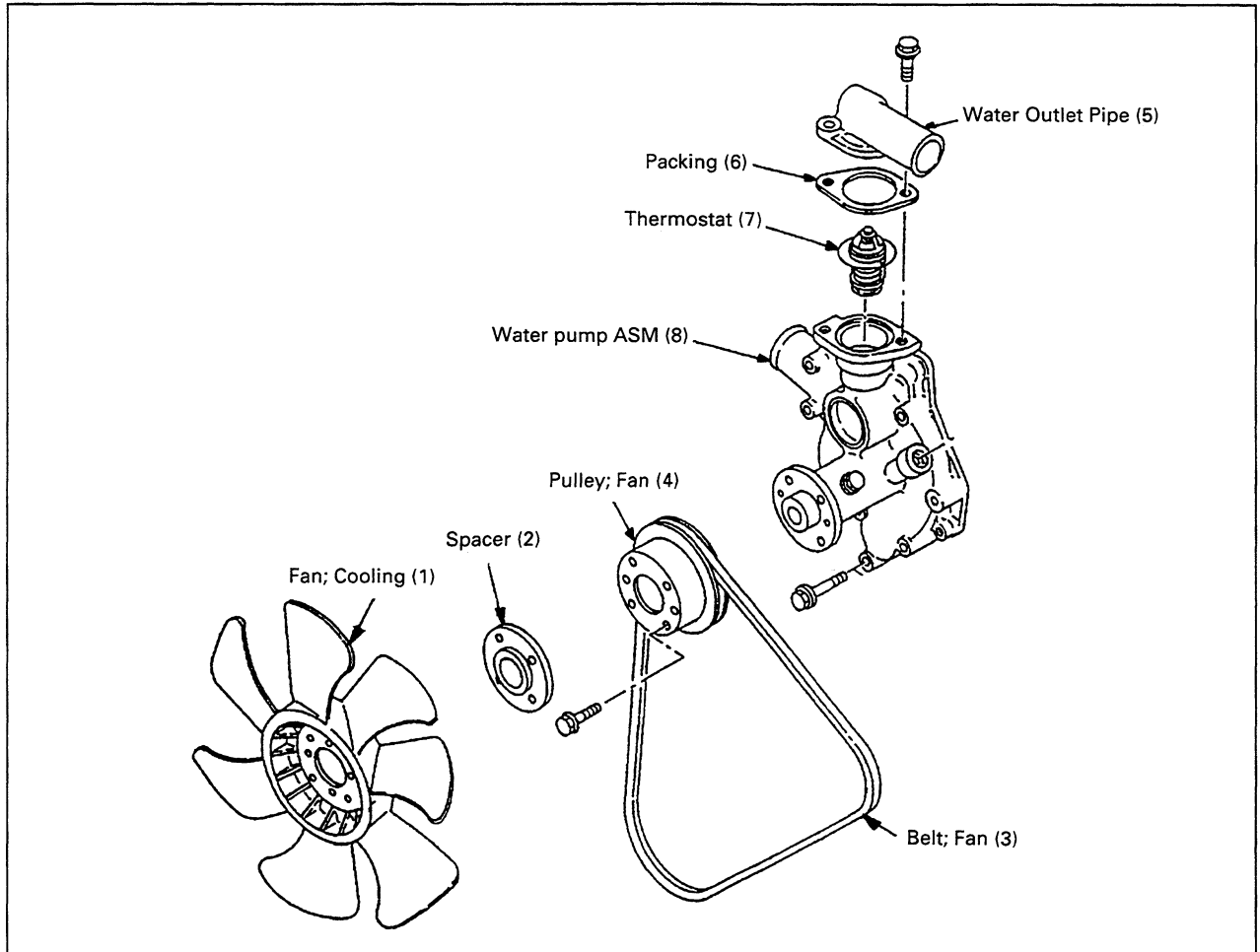


Fig. 1

7. Measurement criteria are defined by the terms “standard” and “limit”.

A measurement falling within the “standard” range indicates that the applicable part or parts are serviceable.

“Limit” should be thought of as an absolute value.

A measurement which is outside the “limit” indicates that the applicable part or parts must be either repaired or replaced.

8. Components and parts are listed in the singular form throughout the Manual.

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9. The following symbols appear throughout this Workshop Manual. They tell you the type of service operation or step to perform.



... Remove



... Adjustment



... Installation



... Cleaning



... Disassembly



... Important Operation Requiring Extra Care



... Reassembly



... Specified Torque (Tighten)



... Alignment (Marks)



... Special Tool Use Required for Recommended (Isuzu Tool or Tools)



... Directional Indication



... Commercially Available Tool Use Required or Recommended



... Inspection



... Lubrication (Oil)



... Measurement



... Lubrication (Grease)



... Liquid Gasket Application

10. Direction used in this Manual are as follows:

Front

The cooling fan side of the engine viewed from the flywheel.

Right

The injection pump side of the engine.

Left

The exhaust manifold side of the engine.

Rear

The flywheel side of the engine.

Cylinder numbers are counted from the front of the engine.

The front most cylinder is No. 1 and rear most cylinder is No.

The engine's direction of rotation is counterclockwise viewed from the flywheel.

APPEARANCE

1. MODELS 3LA1 AND 3LB1

(1) Left side view

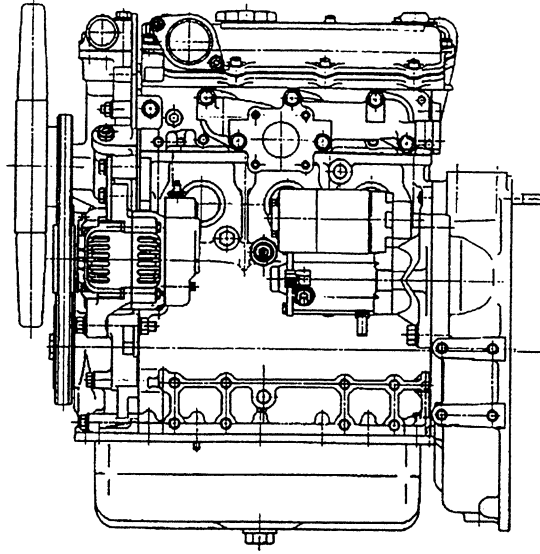


Fig. 2

(2) Right side view

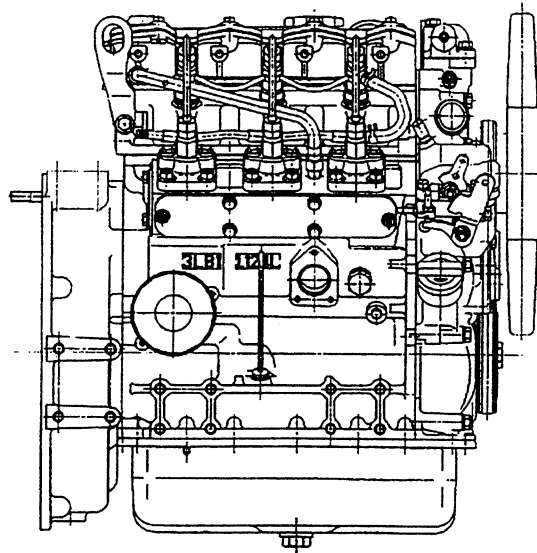


Fig. 3

2. MODEL 3LD1

(1) Left side view

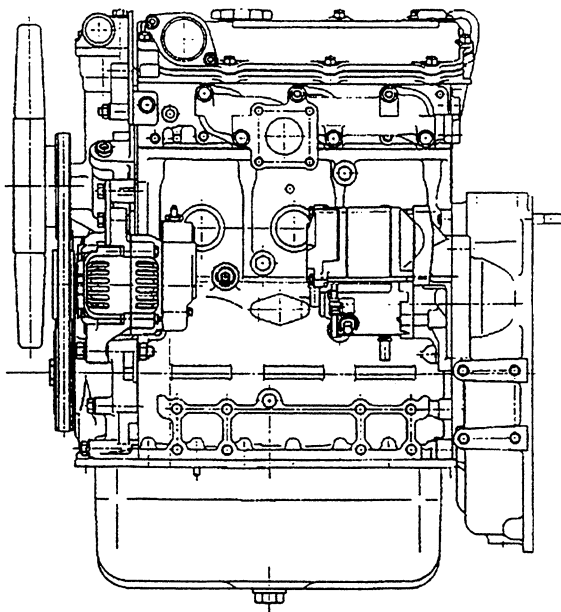


Fig. 4

(2) Right side view

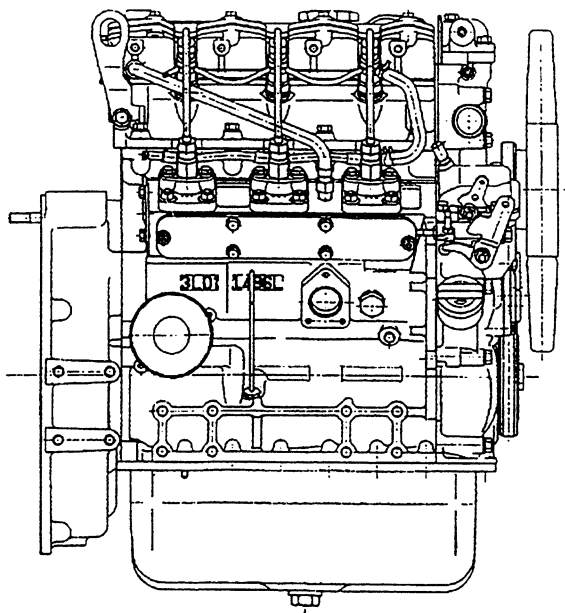


Fig. 5

MAIN DATA AND SPECIFICATIONS

1. MODELS 3LA1 AND 3LB1

| Item | | Engine model(s) | 3LA1 | 3LB1 |
|----------------------------------|---------------|-----------------------|-------------------------------------------------------|-----------------|
| Type | | | In-line water cooled 4-cycle type, OHV: diesel engine | |
| Timing drive system | | | Gear drive | |
| Number of piston rings | | | Compression rings 2, and oil ring 1 | |
| No. of cylinders - bore × stroke | | (mm) | 3 – 70 × 79.7 | 3 – 77.4 × 79.7 |
| Displacement | | (cc) | 920 | 1124 |
| Compression ratio | | | 22 : 1 | |
| Type of combustion chamber | | | Swirl chamber | |
| Overall length × width × height | | (mm) | * 537 × 475 × 553 | |
| Dry weight | | (kg) | * 115 | |
| Fuel injection timing (BTDC) | | (when at stop) | * 19° | |
| Firing order | | | 1 – 3 – 2 | |
| Fuel | | | Hignspeed diesel fuel (SAE No.2) | |
| Idling speed | | (r.p.m) | * 850 | |
| Compression pressure | | | (kg/cm ²) 31 or more/250 r.p.m. | |
| Valve clearance (cold) (mm) | | Intake | 0.20 | |
| | | Exhaust | 0.20 | |
| Valve operating timing | Intake valve | Open (BTDC) | 15° | |
| | | Close (ABDC) | 29° | |
| | Exhaust valve | Open (BBDC) | 40° | |
| | | Close (ATDC) | 16° | |
| Injection pump | | | Bosch type | |
| Governor | | | Mechanical type | |
| Nozzle | | | Throttle type | |
| Injection pressure | | (kg/cm ²) | * 135 | |
| Oil pump | | | Trochoid type | |
| Oil filter | | | Cartridge type | |
| Lubricant capacity: In total | | (l) | * About 5.1 | |
| Generator output | | (V – A) | * 12 – 20 | |
| Starter output | | (V – KW) | * 12 – 1.0 | |

(Note) These specifications may be subject to change without notice.

Figures in the column with an asterisk (*) are different for each machine. Refer to the specifications provided by machine manufacturers.

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2. MODEL 3LD1

| Item | | | Engine model(s) | 3LD1 |
|----------------------------------|---------------|--------------|-------------------------------------------------------|-----------------------|
| Type | | | In-line water cooled 4-cycle type, OHV: diesel engine | |
| Timing drive system | | | Gear drive | |
| Number of piston rings | | | Compression rings 2, and oil ring 1 | |
| No. of cylinders - bore × stroke | | | (mm) | 3 – 83.1 × 92 |
| Displacement | | | (cc) | 1496 |
| Compression ratio | | | 22 : 1 | |
| Type of combustion chamber | | | Swirl chamber | |
| Overall length × width × height | | | (mm) | * 571.5 × 475 × 609 |
| Dry weight | | | (kg) | * 132 |
| Fuel injection timing (BTDC) | | | (when at stop) | * 19° |
| Firing order | | | 1 – 3 – 2 | |
| Fuel | | | Highspeed diesel fuel (SAE No.2) | |
| Idling speed | | | (r.p.m) | * 850 |
| Compression pressure | | | (kg/cm ²) | 31 or more/250 r.p.m. |
| Valve clearance (cold) (mm) | | Intake | 0.20 | |
| | | Exhaust | 0.20 | |
| Valve operating timing | Intake valve | Open (BTDC) | 15° | |
| | | Close (ABDC) | 29° | |
| | Exhaust valve | Open (BBDC) | 40° | |
| | | Close (ATDC) | 16° | |
| Injection pump | | | Bosch type | |
| Governor | | | Mechanical type | |
| Nozzle | | | Throttle type | |
| Injection pressure | | | (kg/cm ²) | * 135 |
| Oil pump | | | Trochoid type | |
| Oil filter | | | Cartridge type | |
| Lubricant capacity: In total | | | (l) | * About 6.8 |
| Generator output | | | (V – A) | * 12 – 20 |
| Starter output | | | (V – KW) | * 12 – 1.2 |










(Note) These specifications may be subject to change without notice.

Figures in the column with an asterisk (*) are different for each machine. Refer to the specifications provided by machine manufacturers.

TIGHTENING TORQUE SPECIFICATIONS

The tightening torque values given in the table below are applicable to the bolts unless otherwise specified.

STANDARD BOLT

| STANDARD BOLT | | kg-m(lb.ft/N-m) | | | |
|----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Strength Class Bolt Identification Bolt Diameter× Pitch (mm) | 4.8 (4T) | (7T) | 8.8 | | 9.8 (9T) |
| | | | Refined | Non-Refined | |
| |  |  |  |  |  |
| |  No mark | — |  |  |  |
| M 6 × 1.0 | 0.60±0.20 (4.33±1.44/5.88±1.96) | 0.75±0.25 (5.43±1.80/7.35±2.45) | | | — |
| M 8 × 1.25 | 1.30±0.50 (9.40±3.62/12.74±4.90) | 1.75±0.55 (12.66±4.00/17.15±5.39) | | | 2.40±0.70 (17.36±5.06/23.52±6.86) |
| M10 × 1.25 | 2.80±0.70 (20.25±5.06/27.44±6.86) | 3.75±0.95 (27.12±6.87/36.75±9.31) | | | 5.10±1.30 (36.89±9.40/49.98±12.74) |
| M12 × 1.25 | 6.25±1.25 (45.21±9.04/61.25±12.25) | 7.75±1.55 (56.06±11.21/75.95±15.19) | | | 9.65±1.95 (69.80±14.10/94.57±19.11) |
| M14 × 1.5 | 9.75±1.95 (70.52±14.10/95.55±19.11) | 11.85±2.35 (85.71±17.00/116.13±23.03) | | | 14.50±2.90 (104.88±21.00/142.10±28.42) |
| M16 × 1.5 | 13.30±2.70 (96.20±19.53/130.34±26.46) | 17.30±3.50 (125.13±25.32/169.54±34.30) | | | 20.40±4.10 (147.55±29.66/199.92±40.18) |
| M18 × 1.5 | 19.20±3.80 (138.87±27.49/188.16±37.24) | 24.90±5.00 (180.10±36.17/244.02±49.00) | | | 29.30±5.90 (211.93±42.67/287.14±57.82) |
| M20 × 1.5 | 26.30±5.30 (190.23±38.33/257.74±51.94) | 34.40±6.90 (248.82±49.41/337.12±67.62) | | | 40.40±8.10 (292.21±58.59/395.92±79.38) |
| M22 × 1.5 | 33.90±8.30 (245.20±60.03/332.22±81.34) | 46.25±9.25 (334.53±66.91/453.25±90.65) | | | 54.10±10.80 (391.30±78.12/530.18±105.84) |
| M24 × 2.0 | 45.80±9.20 (331.27±66.54/448.84±90.16) | 58.20±14.30 (420.96±103.43/570.36±140.14) | | | 70.60±14.10 (510.65±101.99/691.88±138.18) |
| *M10 × 1.5 | 2.70±0.70 (19.53±5.06/26.46±6.86) | 3.70±0.90 (26.76±6.50/36.26±8.82) | | | 4.90±1.20 (35.44±8.68/48.02±11.76) |
| *M12 × 1.5 | 5.80±1.20 (41.95±8.68/56.84±11.76) | 7.20±1.40 (52.08±10.13/70.56±13.72) | | | 9.10±1.80 (65.82±13.02/89.18±17.64) |
| *M14 × 2.0 | 9.10±1.80 (65.82±13.02/89.18±17.64) | 11.20±2.20 (81.01±15.91/109.76±21.56) | | | 13.60±2.70 (98.37±19.53/133.28±26.46) |
| *M16 × 2.0 | 12.70±2.50 (91.86±18.08/124.46±24.50) | 16.50±3.30 (119.34±23.87/161.70±32.34) | | | 19.50±3.90 (141.04±28.21/191.10±38.22) |

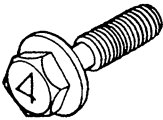
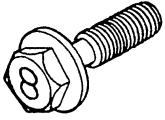
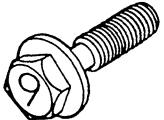
An asterisk (*) indicates that the bolts are used for female threaded parts that are made of soft materials such as casting. Those shown in parentheses in the strength class indicate the classification by the old standard.

TIGHTENING TORQUE SPECIFICATIONS

The tightening torque values given in the table below are applicable to the bolts unless otherwise specified.

FLANGED HEAD BOLT

kg·m (lb.ft/N·m)

| <div style="display: flex; flex-direction: column; align-items: center;"> <div>Bolt head marking</div> <div>Nominal size (dia. x pitch)</div> </div> |  |  |  |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| M 6 × 1 | 0.7±0.2 (3.61~6.50/4.6~8.5) | 0.9±0.3 (4.33~8.67/5.88~11.76) | — |
| M 8 × 1.25 | 1.5 ^{+0.5} _{-0.4} (7.95~14.46/10.78~19.61) | 2.2 ^{+0.7} _{-0.6} (4.33~8.67/5.88~11.76) | 2.6 ^{+0.8} _{-0.7} (13.74~24.59/18.63~33.34) |
| M10 × 1.25 | 3.1 ^{+0.8} _{+0.8} (17.35~28.20/23.53~38.24) | 4.9 ^{+1.5} _{-1.3} (26.03~44.12/35.30~59.82) | 5.7 ^{+1.5} _{-1.4} (31.10~52.07/42.16~70.60) |
| *M10 × 1.5 | 3.0 ^{+0.8} _{-0.7} (16.63~27.48/22.55~37.26) | 4.7 ^{+1.1} _{-1.2} (25.31~41.95/34.32~56.87) | 5.5 ^{+1.3} _{-1.4} (29.65~49.18/40.20~66.68) |
| M12 × 1.25 | 7.0±1.4 (40.50~60.75/54.91~82.37) | 9.9±2.0 (57.14~86.07/77.47~116.69) | 10.8 ^{+2.2} _{-2.1} (62.92~94.02/85.31~127.48) |
| *M12 × 1.75 | 6.5±3 (37.61~56.41/50.99~76.49) | 9.1±1.8 (52.80~78.83/71.58~106.89) | 10.1 ^{+2.1} _{-2.0} (58.58~88.24/79.43~119.64) |
| M14 × 1.5 | 10.6±2.1 (61.48~91.85/83.35~124.54) | 14.6 ^{+3.0} _{-2.9} (84.62~127.30/114.73~172.59) | 15.7 ^{+3.2} _{-3.1} (91.13~136.70/123.56~185.34) |
| *M14 × 2 | 9.5 ^{+2.0} _{-1.9} (57.14~85.34/77.47~115.71) | 13.8 ^{+2.8} _{-2.7} (80.28~120.06/108.85~162.79) | 14.7 ^{+3.0} _{-2.9} (85.34~128.02/115.71~173.57) |
| M16 × 1.5 | 14.7 ^{+3.0} _{-2.9} (85.34~128.02/115.71~173.57) | 21.8±4.7 (125.85~189.50/170.63~256.93) | 22.5 ^{+4.6} _{-4.5} (130.19~196.01/176.52~265.76) |
| *M16 × 2 | 14.0 ^{+2.7} _{-2.8} (81.00~120.79/109.83~163.77) | 20.7 ^{+4.2} _{-4.1} (120.06~180.10/162.79~244.18) | 21.5±4.3 (124.40~186.61/168.67~253.01) |

A bolt with an asterisk (*) is used for female screws of soft material such as cast iron.

ANGULAR NUT AND BOLT TIGHTENING METHOD



1. Carefully wash the nuts and bolts to remove all oil and grease.

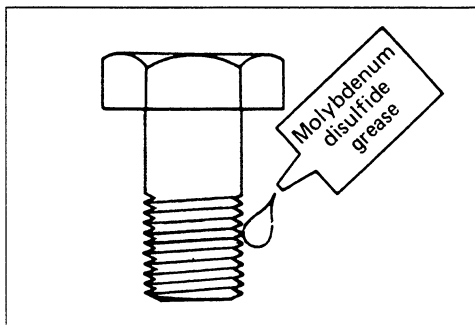


Fig. 6



2. Apply a coat of molybdenum disulfide grease to the threads and setting faces of the nuts and bolts.

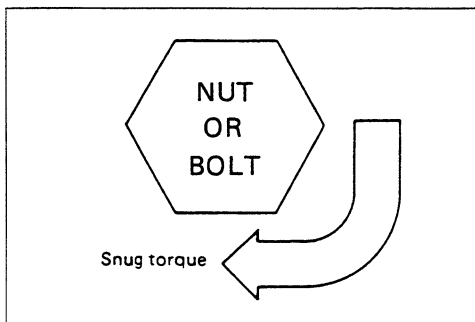


Fig. 7



3. Tighten the nuts and bolts to the specified torque (snug torque) with a torque wrench.

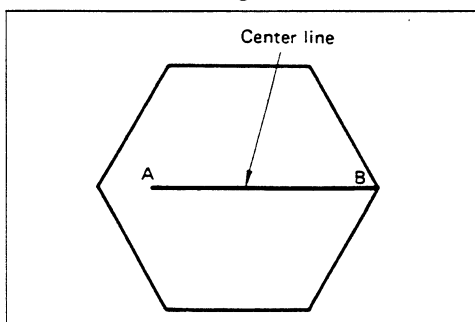


Fig. 8

4. Draw a line [A-B] across the center of each bolt.

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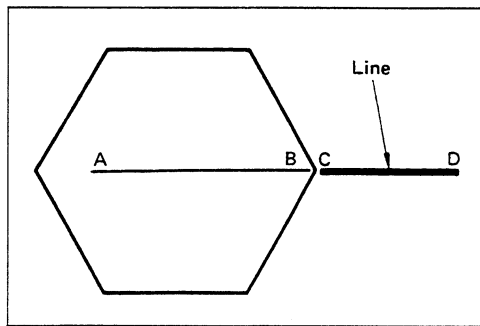


Fig. 9

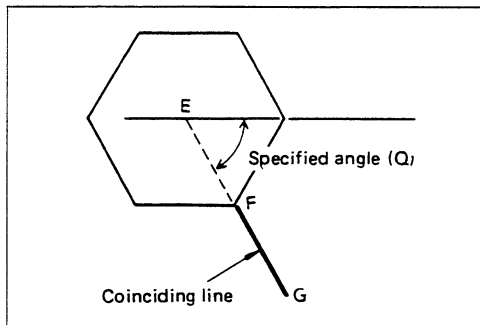


Fig. 10

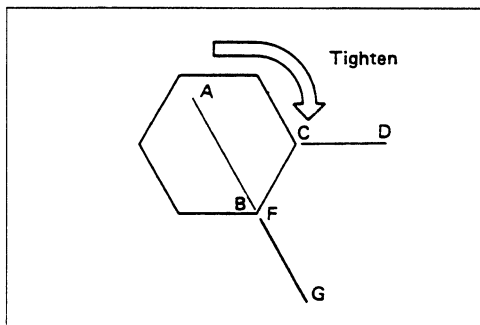


Fig. 11

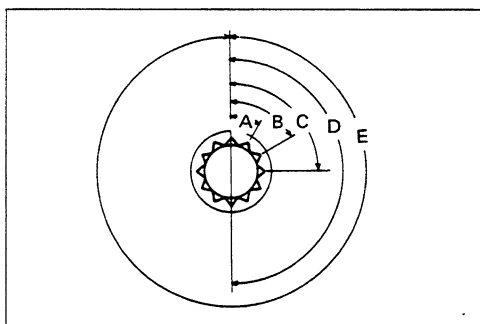


Fig. 12

5. Draw another line [C-D] on the face of each of the parts to be clamped. This line should be an extension of the line [A-B].

6. Draw another line [F-G] on the face of each of the parts to be clamped. This line will be in the direction of the specified angle [Q] across the center [E] of the nut or bolt.

7. Use a socket wrench to tighten each nut or bolt to the point where the line [A-B] is aligned with the line [F-G].



Example: Specified Angle and Tightening Rotation

| | | |
|---|------|----------------|
| A | 30° | 1/12 of a turn |
| B | 60° | 1/6 of a turn |
| C | 90° | 1/4 of a turn |
| D | 180° | 1/2 of a turn |
| E | 360° | One full turn |

TIGHTENING TORQUE ON MAJOR COMPONENTS

1. COOLING FAN AND WATER PUMP

kg·m (ft.·lbs.)

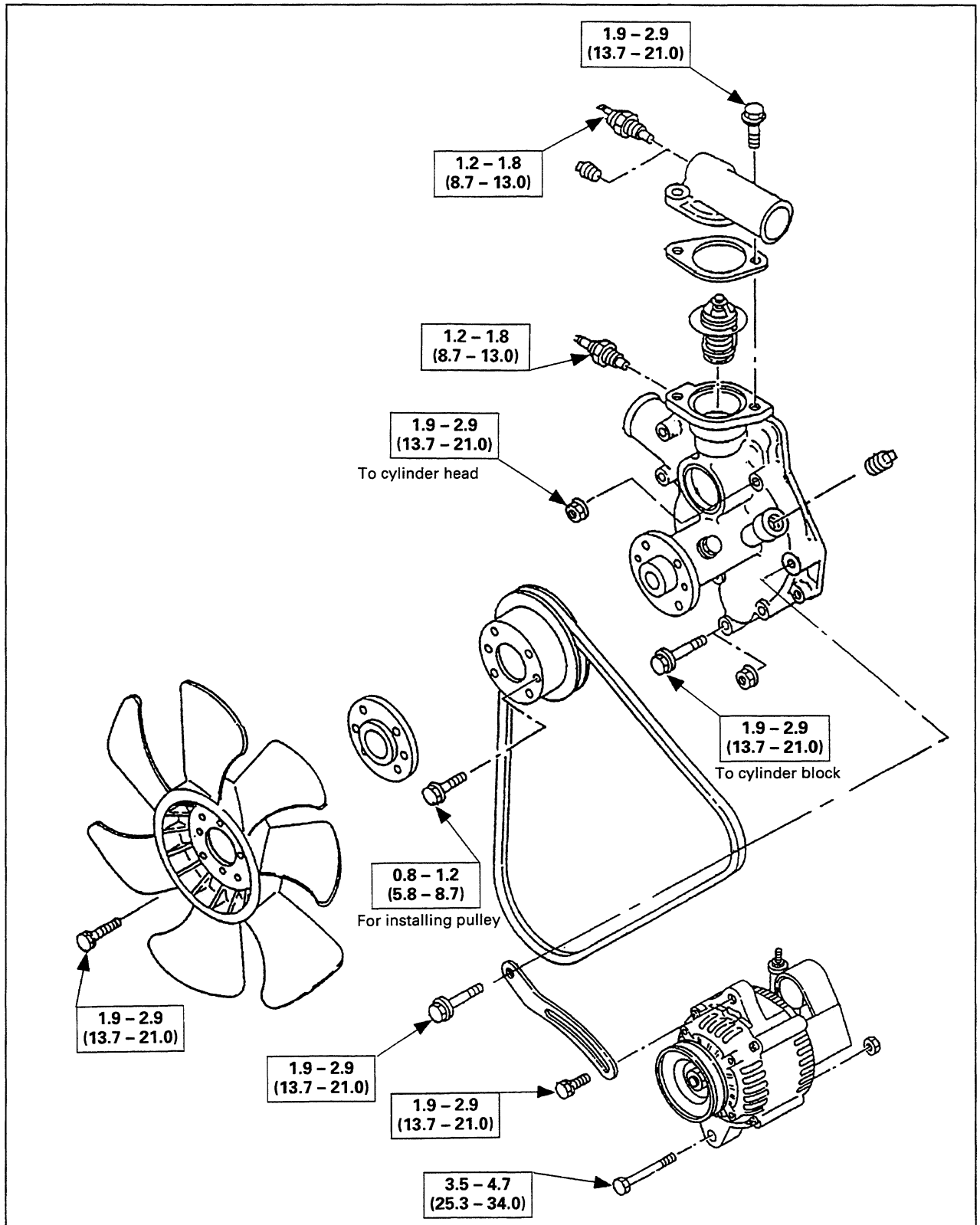


Fig. 13

2. CYLINDER HEAD AND CYLINDER HEAD COVER

kg·m (ft.·lbs.)

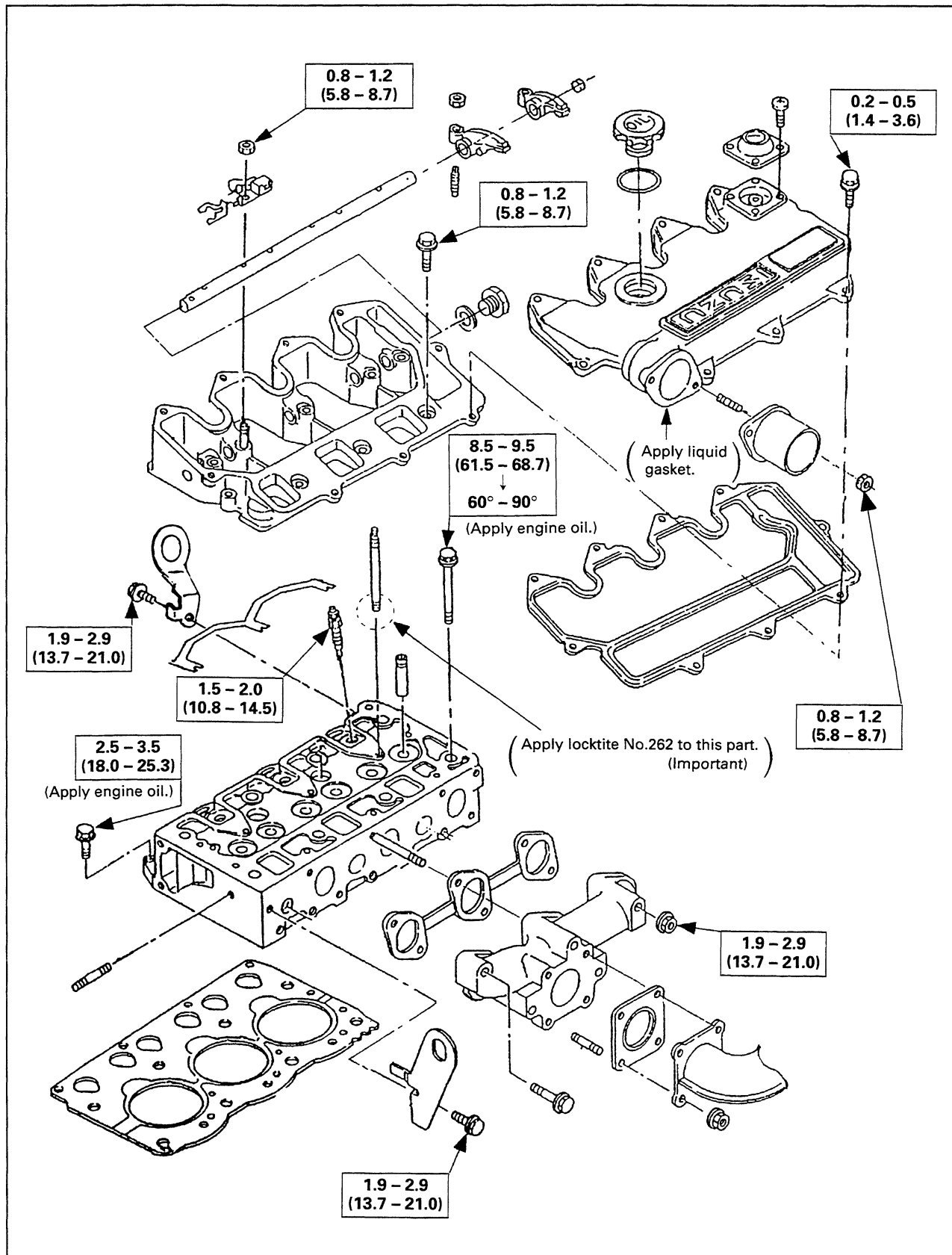


Fig. 14

3. CYLINDER BLOCK AND OTHER COMPONENTS (1)

kg·m (ft.·lbs.)

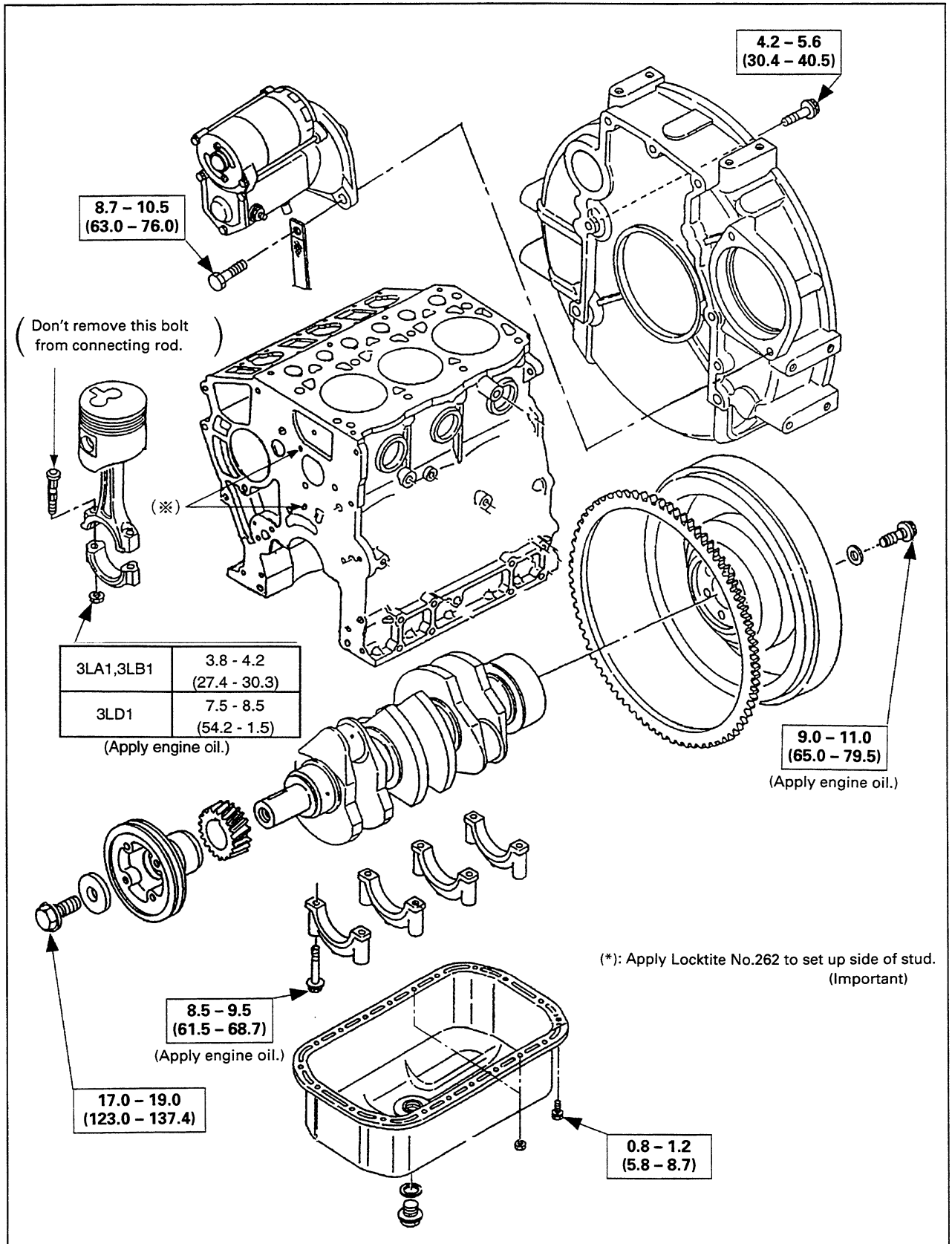


Fig. 15

4. CYLINDER BLOCK AND OTHER COMPONENTS (2)

kg·m (ft.-lbs.)

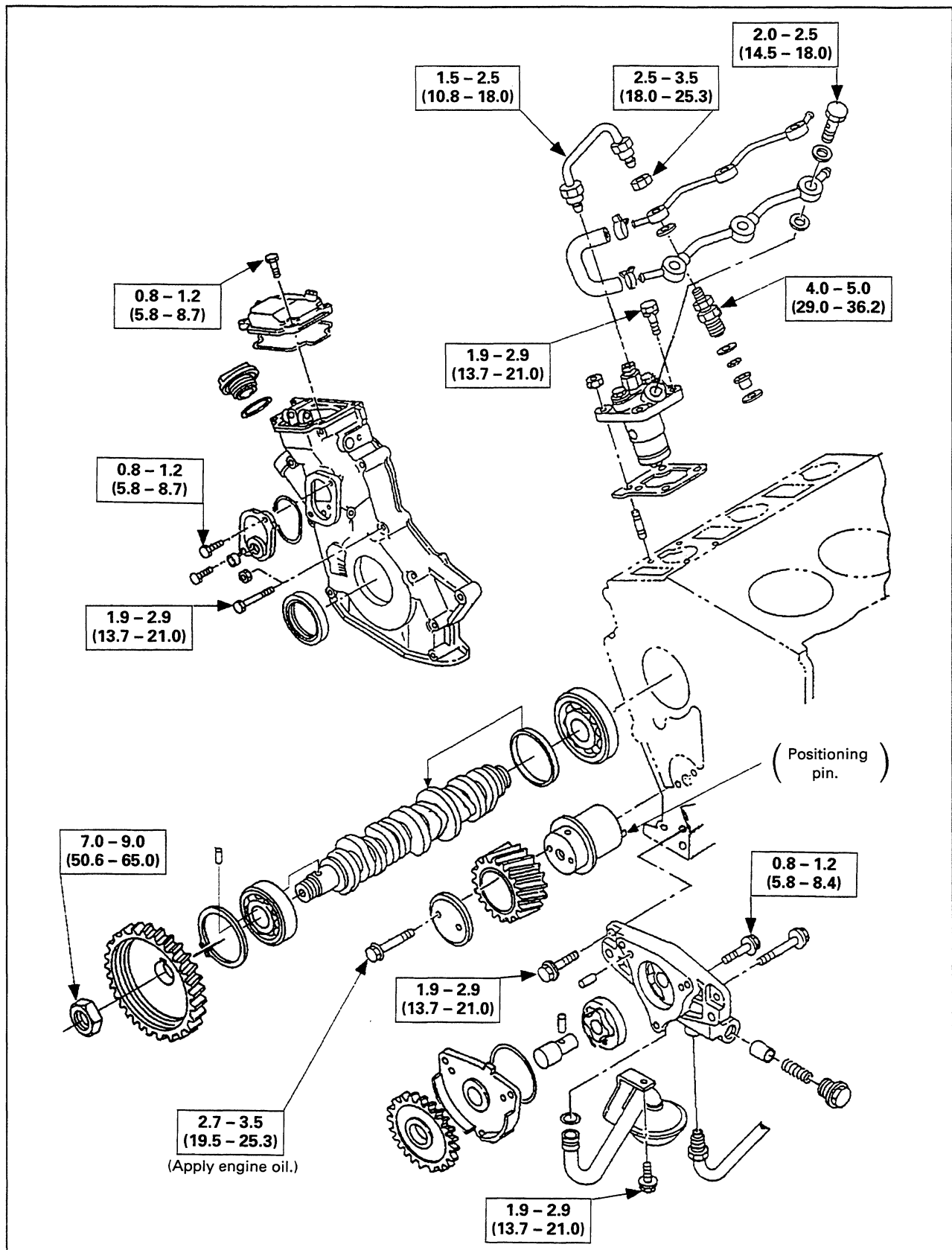


Fig. 16

5. CYLINDER BLOCK AND OTHER COMPONENTS (3)

kg·m (ft.-lbs.)

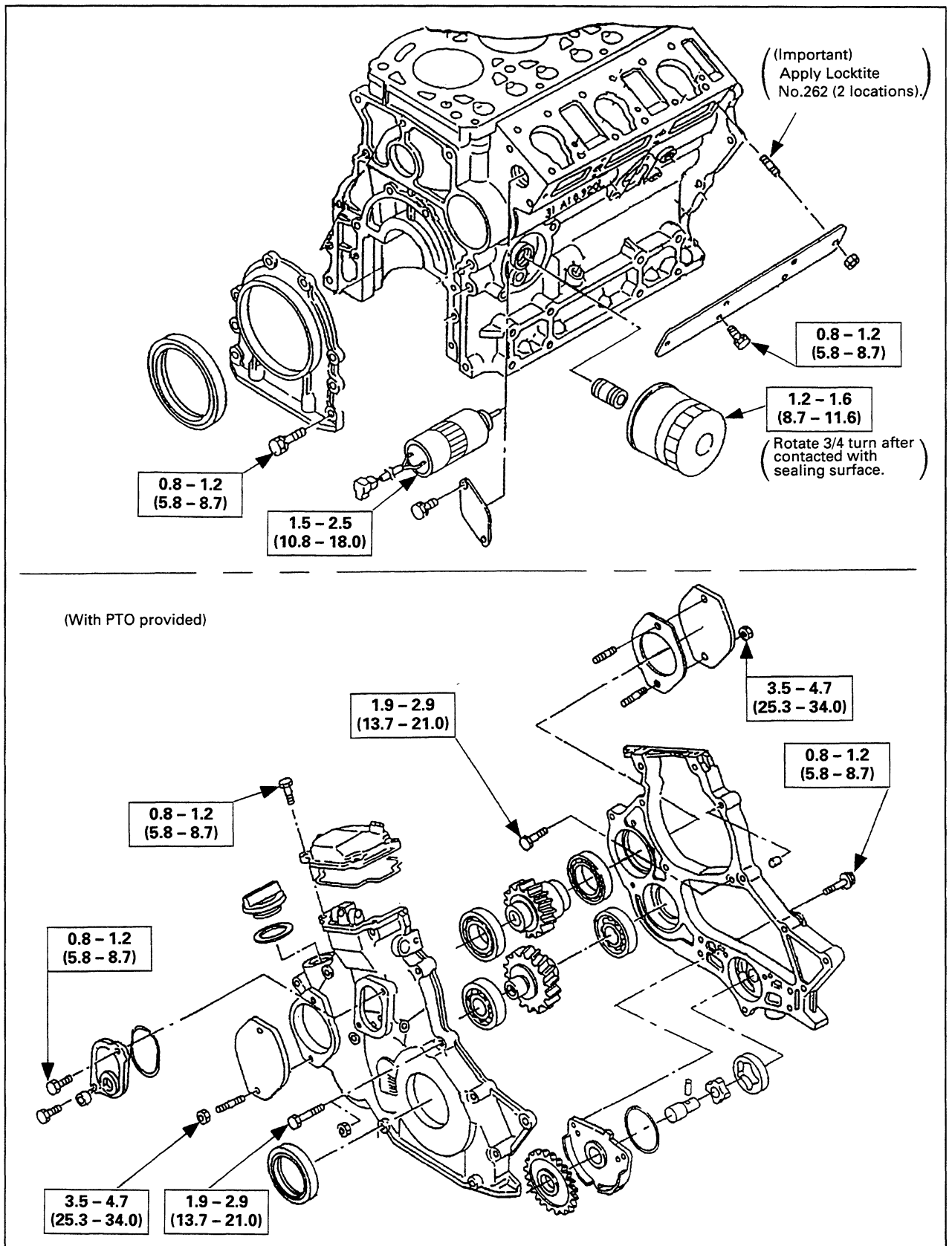


Fig. 17

GASKET LOCATION

1. LOCATIONS WHERE GASKETS ARE USED

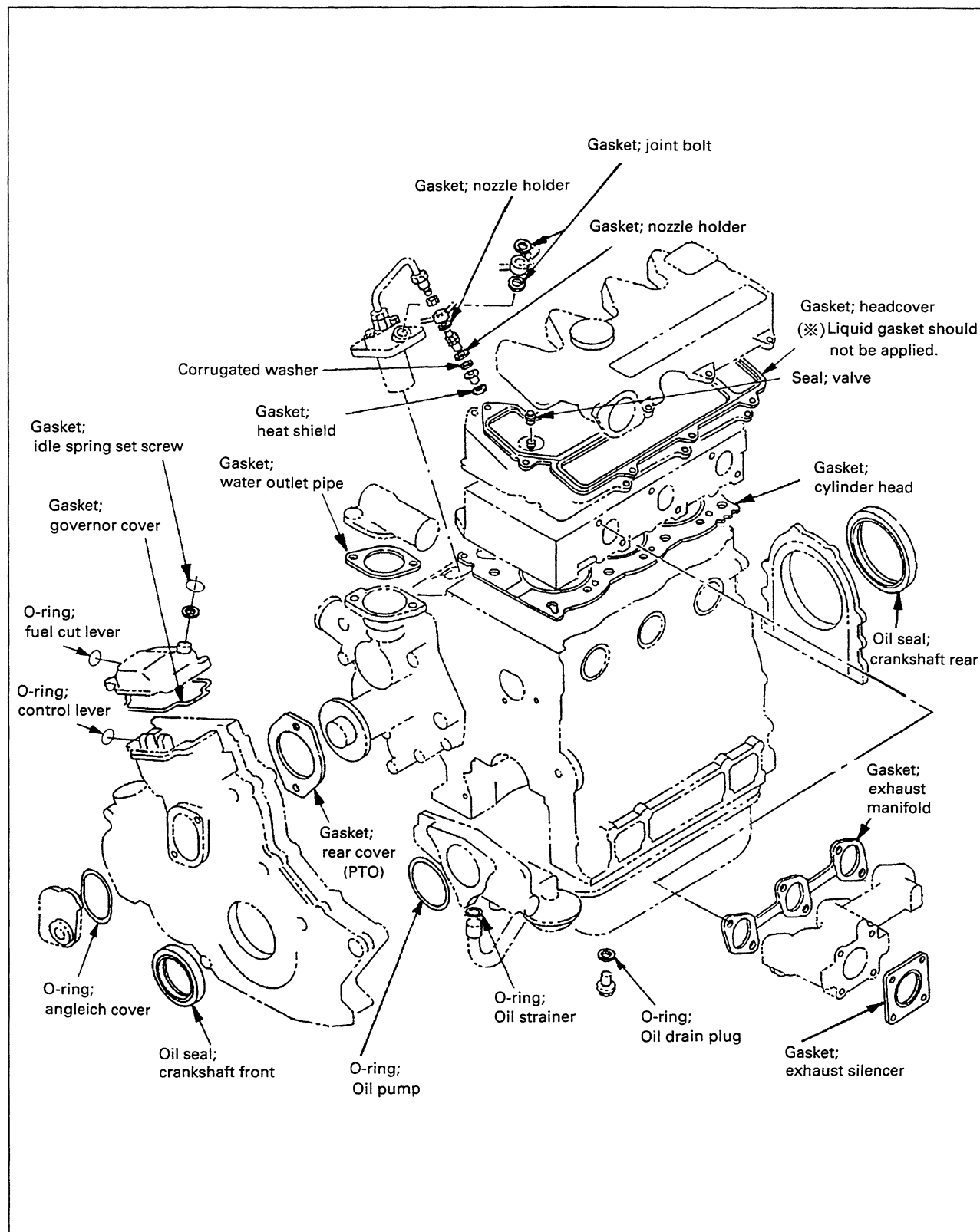


Fig. 18

2. LOCATIONS WHERE LIQUID GASKET IS APPLIED

| | Location | | Condition for use | | Name of liquid gasket |
|----|------------------------------------|---------------------|---------------------|----------------------|-----------------------|
| | Name of part | Name of mating part | Object to be sealed | Groove to be applied | |
| 1 | Oil pan | Cylinder block | Engine oil (10W-30) | Not provided | TB1207C |
| 2 | Rocker bracket | Cylinder head | Engine oil (10W-30) | Provided | TB1207C |
| 3 | Air inlet pipe | Cylinder head cover | Air | Provided | TB1207C |
| 4 | Front plate (with PTO provided) | Cylinder block | Engine oil (10W-30) | Provided | TB1207C |
| 5 | Timing case (with PTO provided) | Front plate | Engine oil (10W-30) | Provided | TB1207C |
| 6 | Timing case (with no PTO provided) | Cylinder block | Engine oil (10W-30) | Provided | TB1207C |
| 7 | Water pump ASM | Cylinder block | Cooling water | Not provided | TB1207C |
| 8 | Rear cover; water pump | Body; water pump | Cooling water | Provided | TB1207B |
| 9 | Housing cover; injection pump | Cylinder block | Engine oil (10W-30) | Provided | TB1207C |
| 10 | Solenoid; fuel cut | Cylinder block | Engine oil (10W-30) | Provided | TB1207C |
| 11 | Retainer; oil seal | Cylinder block | Engine oil (10W-30) | Provided | TB1207C |
| 12 | Indicator; air cleaner | Air cleaner | Air | Not provided | (Sealing tape) |

Fig. 19

MAINTENANCE

1. VALVE CLEARANCE AND ADJUSTMENT

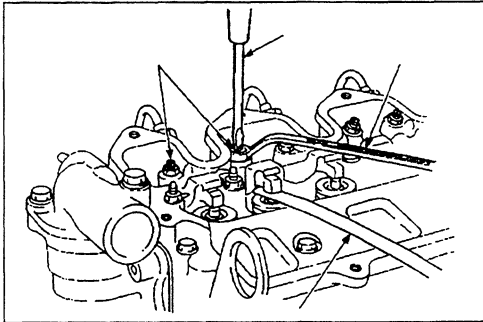


Fig. 20

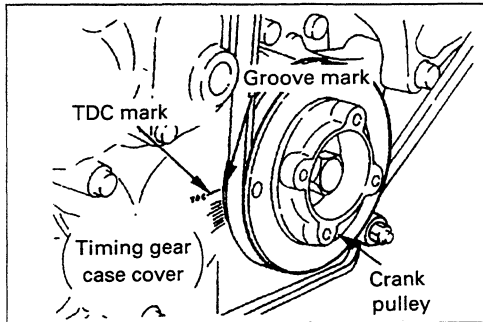


Fig. 21

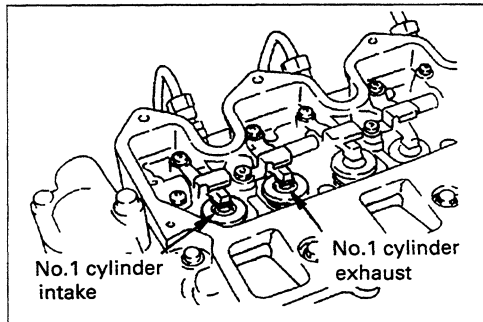


Fig. 22

| Cylinder No. | 1 | | 2 | | 3 | |
|------------------------------------|---|---|---|---|---|---|
| Valve arrangement | I | E | I | E | I | E |
| No. 1 cylinder TDC for compression | ○ | ○ | ○ | | | ○ |
| No. 1 cylinder TDC for exhaust | | | | ◎ | ◎ | |

I ; Intake E ; Exhaust

Fig. 23

Note:

The cylinder head bolts were previously tightened with the "Angular Tightening Method". Therefore, it is not necessary to retighten the cylinder head bolts before adjusting the valve clearance.



1. Bring the piston in either the No. 1 cylinder or the No. 3 cylinder to Top Dead Center on the compression stroke by turning the crankshaft until the TDC mark on the front cover aligns with the groove mark on the crankshaft pulley.

2. Check to see if there is play in the No. 1 intake and exhaust valve rocker arms.

If the No. 1 cylinder intake and exhaust valve rocker arms have play, the No. 1 piston is at TDC on the compression stroke.

If the No. 1 cylinder intake and exhaust valve rocker arms are depressed, the No. 3 piston is at TDC on the compression stroke.

Adjust the No. 1 or the No. 3 cylinder valve clearances while their respective cylinders are at TDC on the compression stroke.

mm (in.)

| | |
|-------------------------------------------|-----------------------------|
| Intake and Exhaust Valve Clearance (cold) | 0.20 ± 0.05 (0.008 ± 0.002) |
|-------------------------------------------|-----------------------------|



3. Loosen each valve clearance adjusting screw as shown in the illustration.
4. Insert a 0.20 mm (0.008 in) feeler gauge between the rocker arm and the valve stem end.
5. Turn the valve clearance adjusting screw until a slight drag can be felt on the feeler gauge.
6. Tighten the lock nut securely.
7. Rotate the crankshaft 360°.

Realign the crankshaft pulley.
8. Adjust the clearances for the remaining valves as shown in the illustration.

2. LUBRICATIN SYSTEM

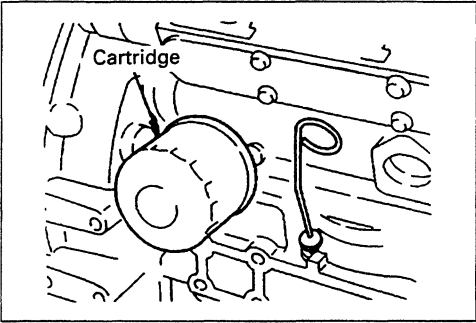


Fig. 24



Cartridge (Spin-On) Type

Removal

Remover and Installer: Filter Wrench

1. Loosen the used oil filter by turning it counterclockwise with the filter wrench.
2. Discard the used oil filter.

Installation

1. Wipe the oil filter mounting face with a clean rag.
This will allow the new oil filter to seat properly.
2. Lightly oil the O-ring.
3. Turn in the new oil filter until the sealing face is fitted against the O-ring.
4. Use the filter wrench to turn in the oil filter an additional 3/4 of a turn or one turn.
5. Check the engine oil level and replenish to the specified level if required.
6. Start the engine and check for oil leakage from the oil filter.

3. COOLING SYSTEM

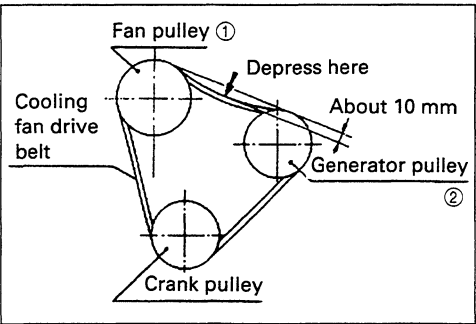


Fig. 25



Cooling Fan Drive Belt

Adjustment

1. Check the cooling fan drive belt for cracking and other damage.
2. Check the drive belt tension by exerting a force of 10 kg (22 lb) midway between the Fan pulley ① and the Generator pulley ②.
3. Adjust the belt tension by loosening the Generator mounting bolt and the Generator adjusting bolt and pivoting the Generator.

Be sure to retighten the bolts after adjusting the belt tension.

mm (in.)

| | |
|-----------------------------------|---------------------------|
| Cooling Fan Drive Belt Deflection | 8.0 – 12.0 (0.3 – 0.5) |
|-----------------------------------|---------------------------|

4. INJECTION TIMING

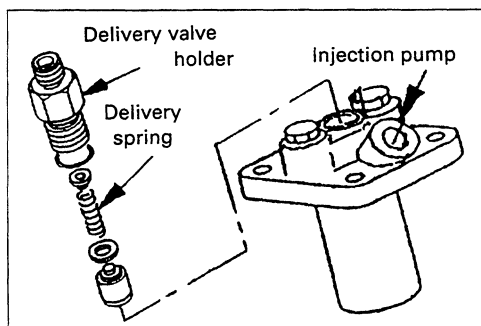


Fig. 26

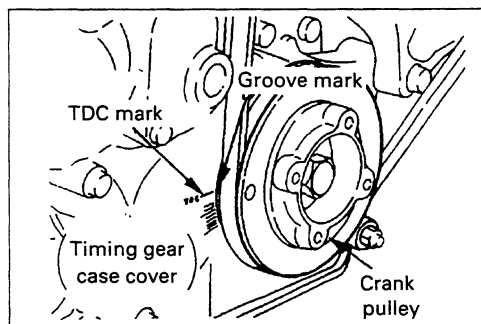


Fig. 27

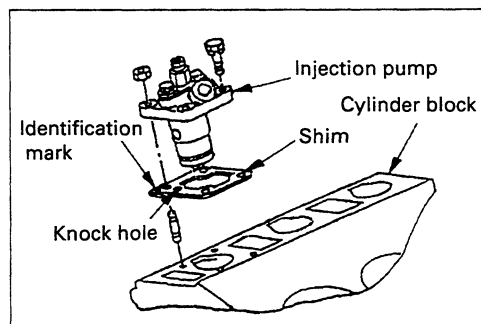


Fig. 28

**Note:**

Take care to avoid entry of dust or foreign particles into the pump interior when the timing adjustment is made.



- (1) Remove the injection pipe of the No. 1 cylinder.
- (2) Remove the delivery valve holder of the injection pump of the No. 1 cylinder, and then pull out the delivery spring.
- (3) With the spring left removed, install the delivery valve holder.
- (4) Slowly turn the crankshaft pulley clockwise, at the same time, continue to feed the fuel.

When the fuel stop flowing out from the No. 1 delivery valve holder, stop turning the crankshaft.

This crank angle position is the starting point of injection.



- (5) In the condition at Step (4) above, confirm what degree the "groove mark" of the crank pulley is at, when seen by the "timing mark", provided in the timing gear case.

When the value is out of the range of the normal injection timing, adjust it accordingly.

| | | |
|--------------------|------------------|----------|
| * Injection timing | 3LA1, 3LB1, 3LD1 | BTDC 19° |
|--------------------|------------------|----------|

Note:

The injection timing varies according to the specifications of the machine.



- (6) Adjust the injection timing with a shim between the injection pump and the cylinder block.

Shim is available in the following 9 types, and "identification mark" is stamped (or imprinted) on the top face.

Identification mark of shim and its thickness (mm)

| Mark | Thickness | Mark | Thickness | Mark | Thickness |
|------|-----------|------|-----------|------|-----------|
| 2 | 0.2 | 5 | 0.5 | 8 | 0.8 |
| 3 | 0.3 | 6 | 0.6 | 10 | 1.0 |
| 4 | 0.4 | 7 | 0.7 | 12 | 1.2 |

Note:

For each of the injection pumps of three cylinders, the shim adjustment is made at the same time.

When a shim is missing while overhauling the engine and the shim thickness is unknown, assemble the engine with provisional shim inserted. After assembling the engine, check the injection timing and adjust the shim until the normal injection timing is obtained.

Reference:

To add the 0.1 mm shim thickness corresponds to the 1 degree of crankshaft angle advance.

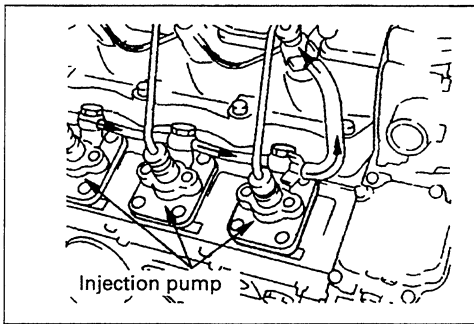


Fig. 29

**Air bleeding from fuel (automatic air-bleeding system)****1. For the automatic air-bleeding system**

When the starter switch is set to "OPERATION", the electromagnetic pump is activated to force-feed fuel to the fuel pipe and the leak-off pipe, and air in the fuel system is automatically bled.

2. For non-automatic air-bleeding system

While sending fuel by means of the force of the electromagnetic pump, the fall from the fuel tank or the feed pump lever, bleed air out of the fuel pipe eye bolt of the No. 1 cylinder injection pump, the leak-off pipe eye bolt of the injection nozzle and the air-bleeder plug of the fuel filter, starting with the one installed the lower most and upward.

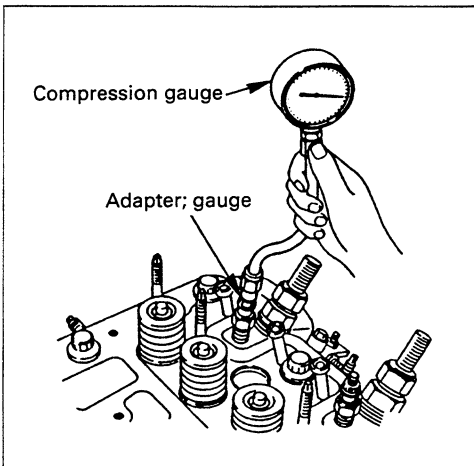
5. COMPRESSION PRESSURE MEASUREMENT

Fig. 30



1. Operate the engine to warm-up until the coolant temperature reaches to 75°C (167°F).
2. Remove all of the glow plugs and the injection pipes.
3. Attach a compression gauge to the No. 1 cylinder glow plug installation threads.

Note:

Compression pressure may be measured starting at any cylinder and in no particular cylinder order. However, it is very important that the compression pressure be measured in each cylinder.

Therefore, start at the No. 1 cylinder and work back. In this way, you will be sure to measure the compression pressure in each cylinder.



Compression Gauge 508840-2008-0



Compression Gauge Adapter 508840-2009-0

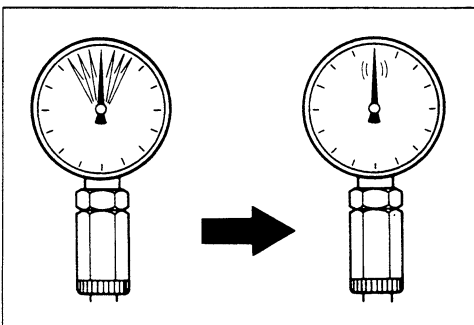


Fig. 31

4. Crank the engine with the starter motor and take the compression gauge reading.

| kg/cm ² (psi) at 250 rpm | |
|-------------------------------------|------------|
| Standard | Limit |
| 31.0 (441) | 26.0 (370) |

5. Repeat the procedure (Steps 3 and 4) for the remaining cylinders.

Compression pressure should be approximately the same for each cylinder. A variation exceeding 2.0 kg/cm² (28.44 psi) is unacceptable.

If the measured value exceeds the specified limit, the related parts must be checked.

6. FUEL SYSTEM

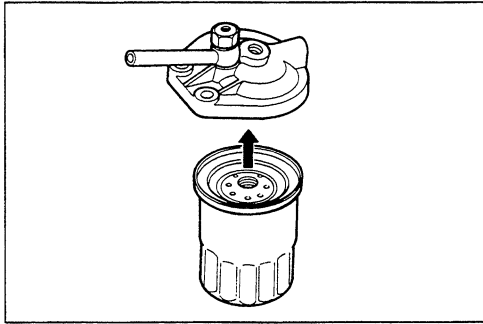


Fig. 32

Fuel Filter Replacement

Cartridge (Spin-On) Type



Removal

1. Loosen the fuel filter by turning it counterclockwise with the filter wrench or your hand. Discard the used filter.



Filter Wrench

2. Wipe the fuel filter fitting face clean with a rag. This will allow the new fuel filter to seat properly.



Installation

1. Apply a light coat of engine oil to the O-ring.
2. Supply fuel to the new filter. This will facilitate air bleeding.
3. Turn in the new fuel filter until the filter O-ring is fitted against the sealing face.
4. Use the filter wrench to turn in the fuel filter an additional 2/3 of a turn.

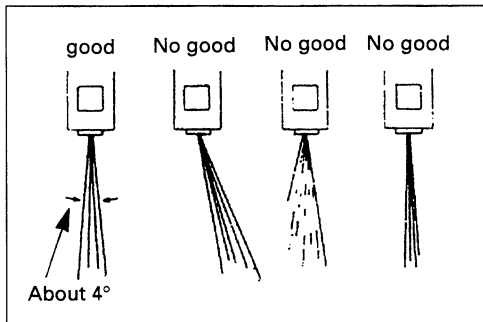


Fig. 33



Injection nozzle

Check to see if the spray condition and the injection pressure are normal. Adjust them to the specified value respectively when they don't meet the standard value.

kg/cm² (PSI)

| | | |
|--------------------|------|---------------|
| Injection pressure | 3LA1 | 135 (1920) |
| | 3LB1 | |
| | 3LD1 | |

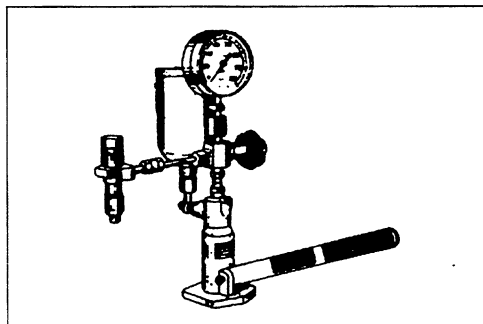


Fig. 34



Using a nozzle tester, adjust the injection pressure with a shim.



Special tool: Nozzle tester

RECOMMENDED LUBRICATING OIL

| | |
|--------------------------|-----------------------------------|
| TYPE OF LUBRICANTS (API) | DIESEL ENGINE OIL; CC OR CD GRADE |
|--------------------------|-----------------------------------|

ENGINE OIL VISCOSITY CHART

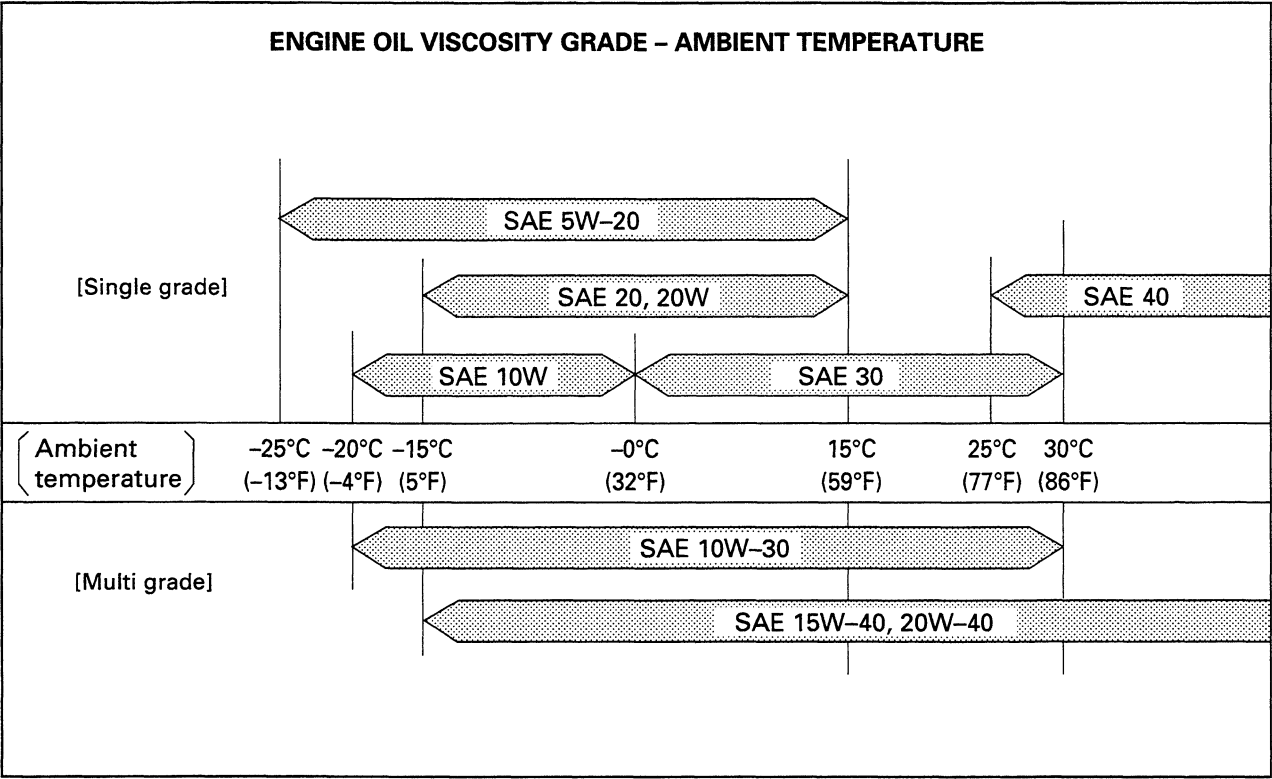


Fig. 35

MEMO

This image shows a full page of a handwriting practice worksheet. It consists of numerous horizontal dashed lines spaced evenly across the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

SECTION 2

ENGINE

TABLE OF CONTENTS

| CONTENTS | PAGE |
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| GENERAL VIEW OF ENGINE | 28 |
| DISASSEMBLY | 29 |
| INSPECTION AND REPAIR | 43 |
| REASSEMBLY | 59 |

GENERAL VIEW OF ENGINE

Models 3LA1, 3LB1

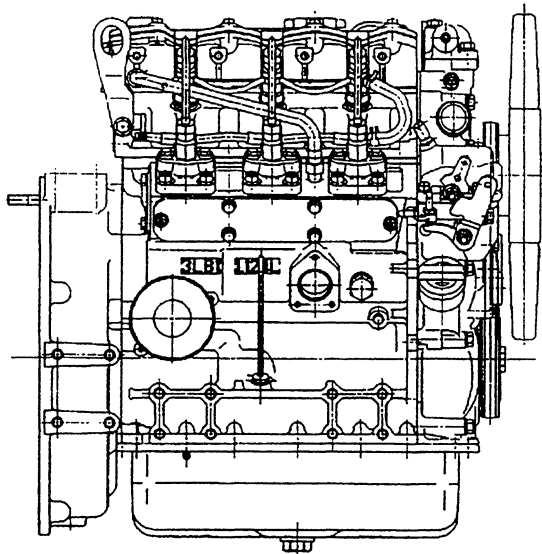


Fig. 36

Model 3LD1

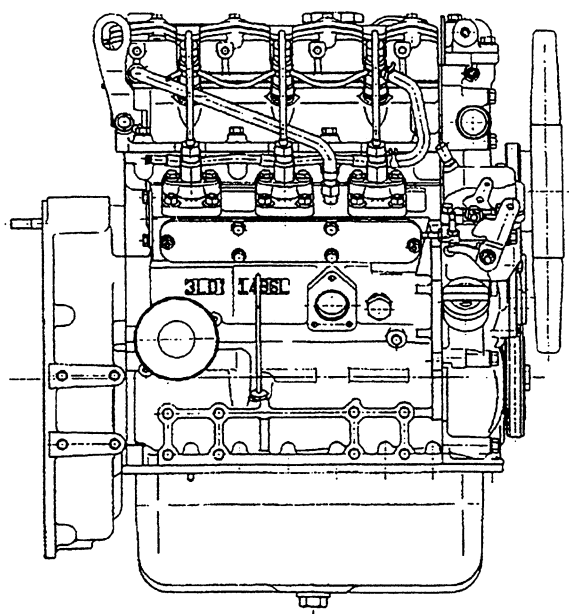


Fig. 37

DISASSEMBLY

1. EXTERNAL PARTS (Left-hand side)

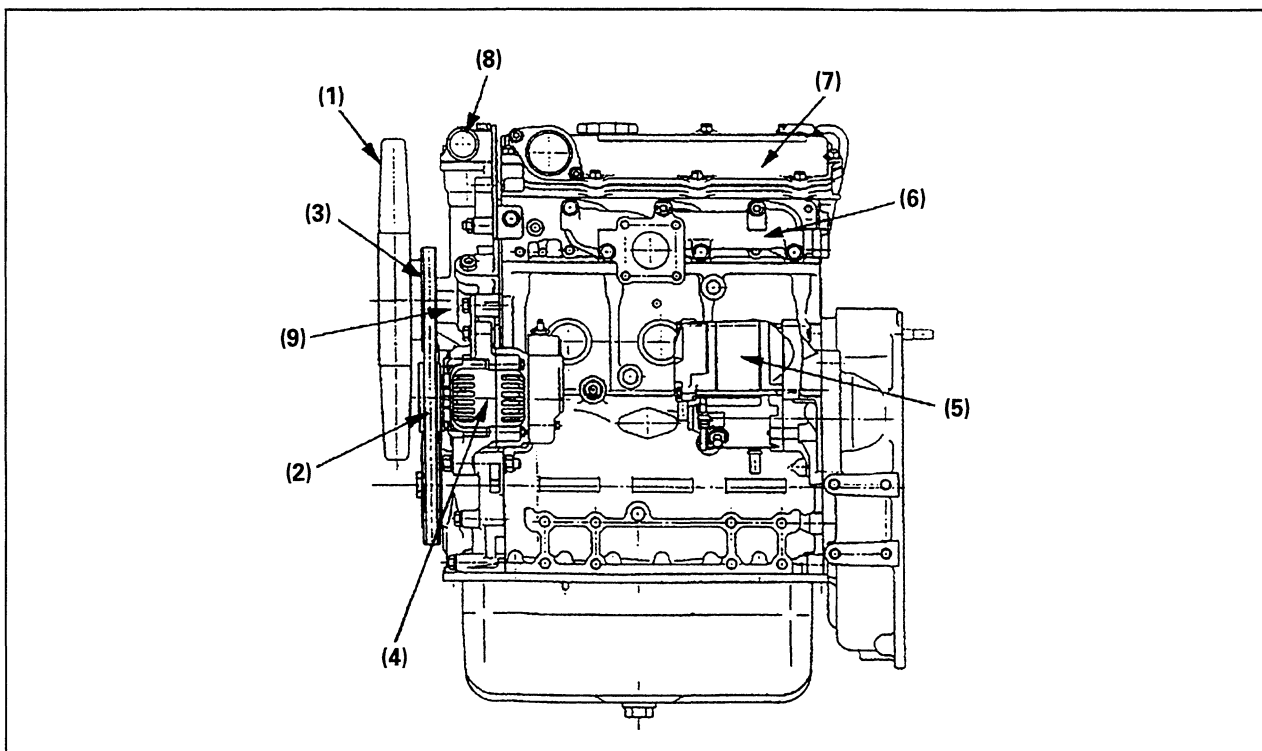


Fig. 38



- (1) Cooling fan and spacer
- (2) Fan belt
- (3) Fan pulley
- (4) Generator
- (5) Starter
- (6) Exhaust manifold and gasket
- (7) Cylinder head cover and air intake pipe
- (8) Water outlet pipe and thermostat
- (9) Water pump assembly

2. EXTERNAL PARTS (Right-hand side)

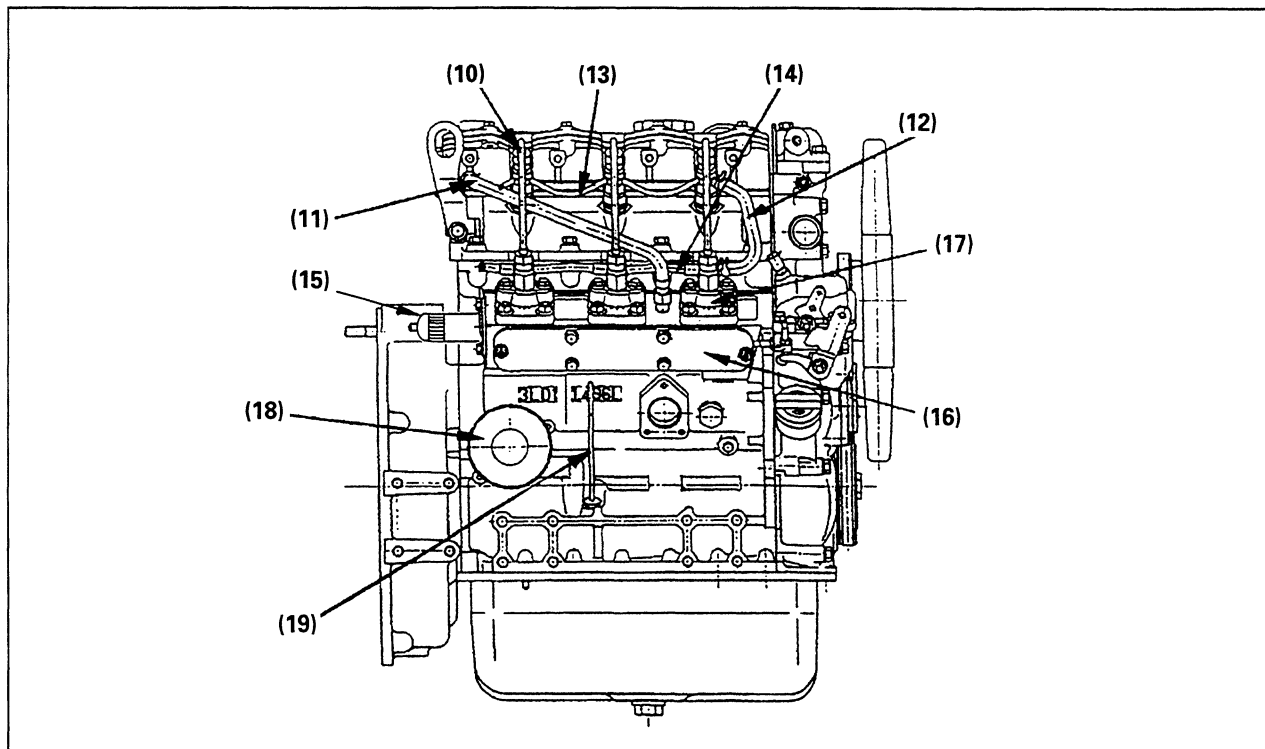


Fig. 39



- (10) Injection pipe 3 pcs.
- (11) Blow by hose
- (12) Fuel hose
- (13) Fuel leak off pipe
- (14) Fuel pipe
- (15) Engine stop solenoid
- (16) Injection pump housing cover
- (17) Injection pump and shim 3 set
- (18) Oil filter
- (19) Oil level gauge

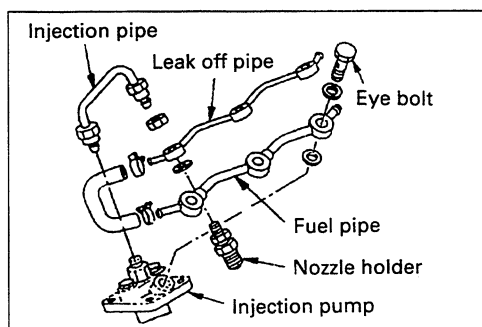


Fig. 40

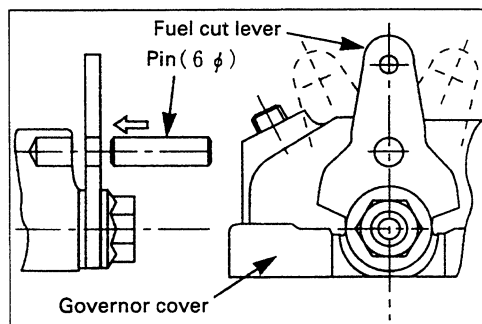


Fig. 41

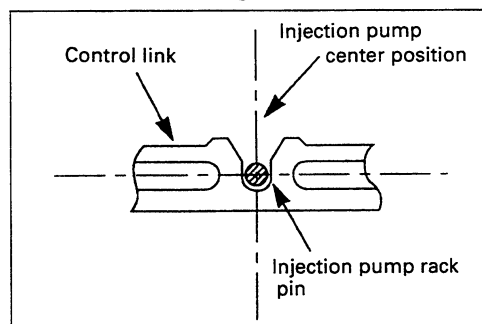


Fig. 42

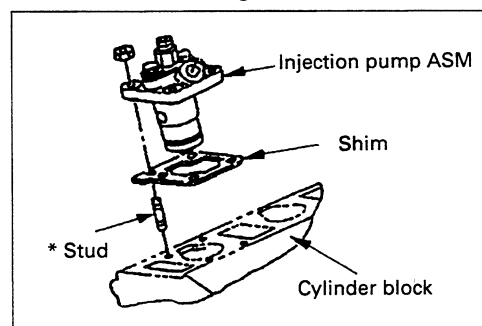


Fig. 43

**Injection pipe****Leak off pipe****Fuel pipe**

1. Loosen the sleeve nuts on the nozzle holder side and on the injection pump side, and then disconnect the injection pipes.
2. Disconnect the leak off pipe together with gaskets.
3. Remove the eye bolt, and then disconnect the fuel pipe.

**Injection pump**

1. Align the hole of the fuel cut lever with the hole of the governor cover, and then insert a pin (6φ) into this hole to hold the fuel cut lever.
2. Check to see if the pin groove of the control link is at the center of the injection pump.
3. Remove the injection pump, and then take out the shim.

**NOTE:**

1. **Mark each injection pump as to which cylinder it was removed from.**
2. **Do not reuse the shim, replace it with the same thickness that was removed.**

**Backlash of timing gear**

mm (in.)

| | STANDARD | LIMIT |
|---------------------------|------------------|-----------------|
| CRANK GEAR/ IDLER GEAR | 0.07 (0.0028) | 0.2 (0.0079) |
| CAM GEAR/ IDLER GEAR | 0.06 (0.0024) | 0.2 (0.0079) |

IDLER GEAR END PLAY

mm (in.)

| STANDARD | LIMIT |
|---------------------------------|--------------|
| 0.058 – 0.115 (0.0023 – 0.0045) | 0.2 (0.0079) |

CRANKSHAFT END PLAY

mm (in.)

| STANDARD | LIMIT |
|-------------------------------|--------------|
| 0.06 – 0.26 (0.0024 – 0.0102) | 0.3 (0.0118) |

3. INTERNAL PARTS



Disassembly Steps

- (1) Rocker Bracket Assembly**
- (2) Push Rods**
- (3) Rear Hanger**
- (4) Front Hanger**
- (5) Cylinder Head Assembly**
- (6) Cylinder Head Gasket**
- (7) Tappets**
- (8) Oil Pan**
- (9) Oil Strainer**
- (10) Oil Pipe**
- (11) Crank Pulley**
- (12) Flywheel**
- (13) Flywheel Housing**
- (14) Timing Gear Case (without PTO)**
- (15) Oil Pump Assembly**
- (16) Idler Gear and Shaft**
- (17) Cam Gear**
- (18) Camshaft**
- (19) Rear Seal Retainer**
- (20) Piston Assemblies**
- (21) Crankshaft**



Internal Parts (1/3)

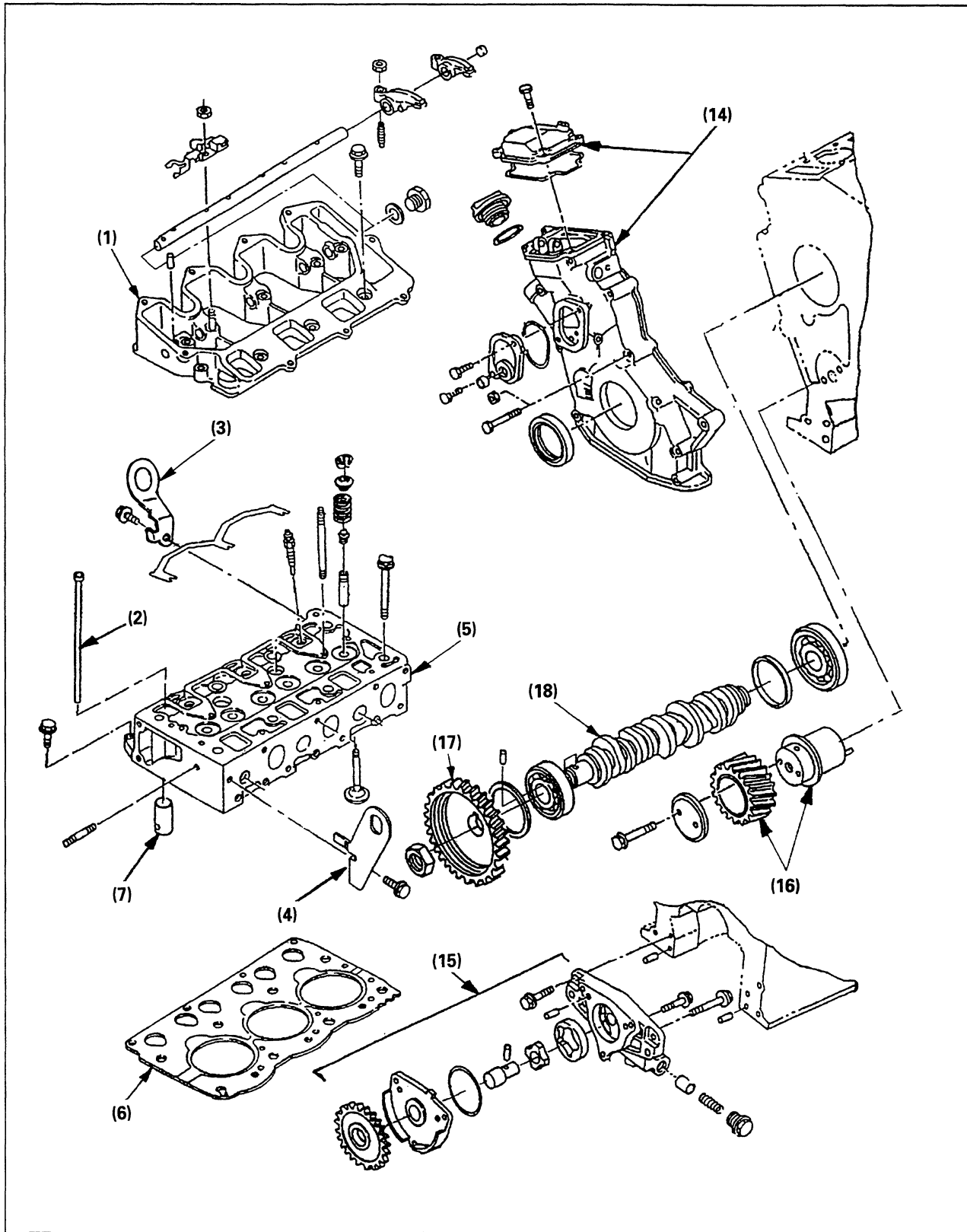


Fig. 44



Internal Parts (2/3)

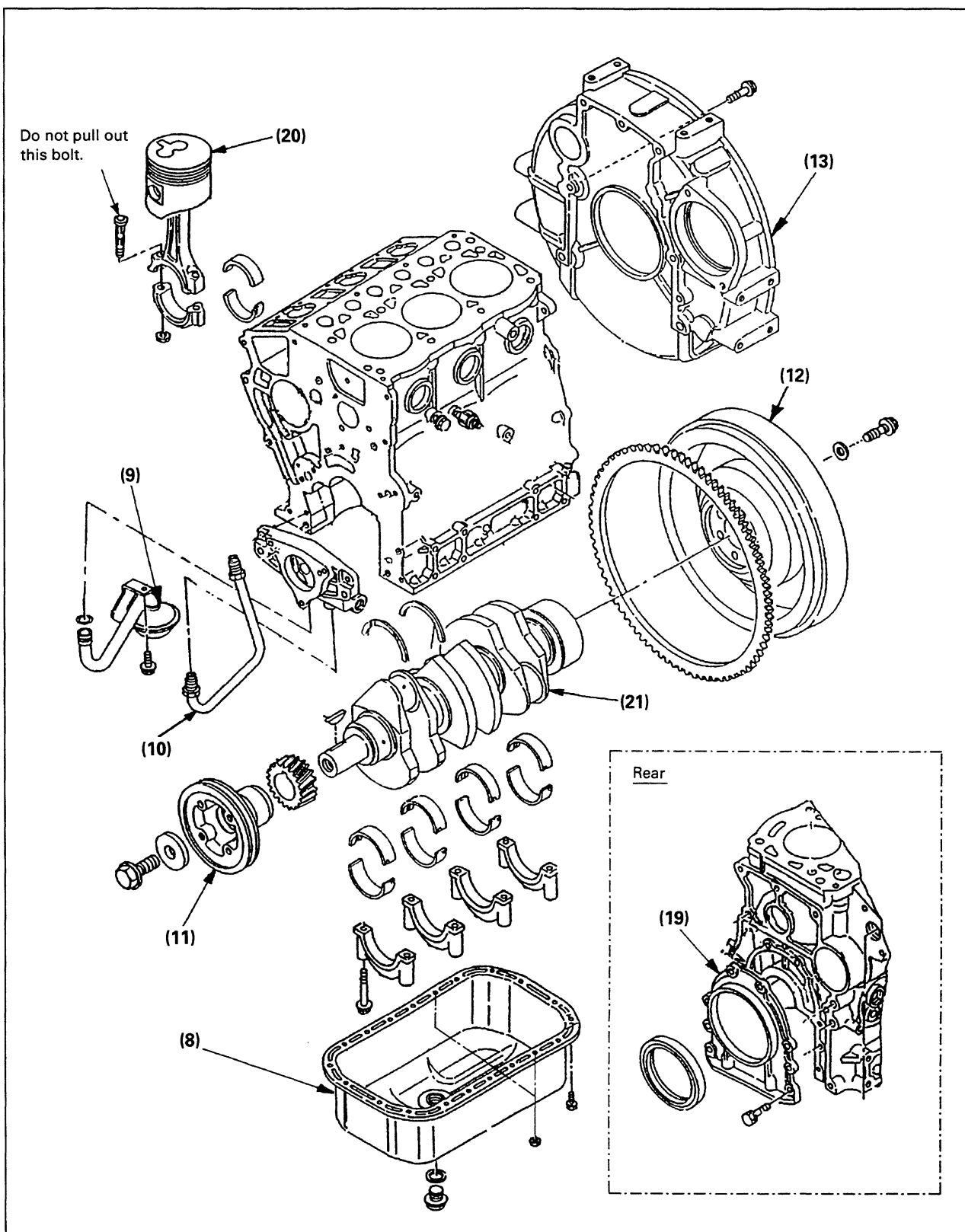


Fig. 45



Internal Parts (3/3)

When provided with PTO

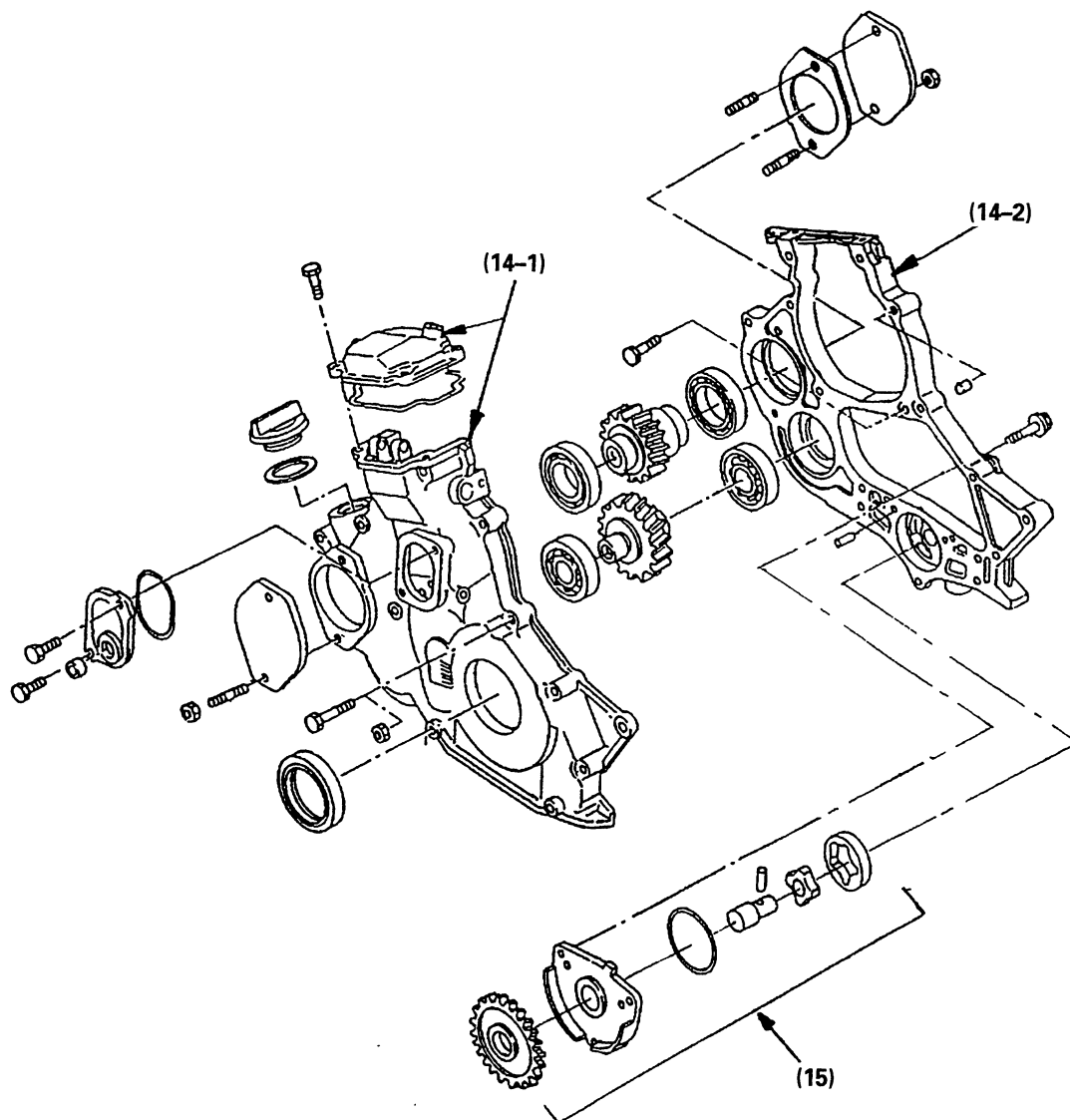


Fig. 46

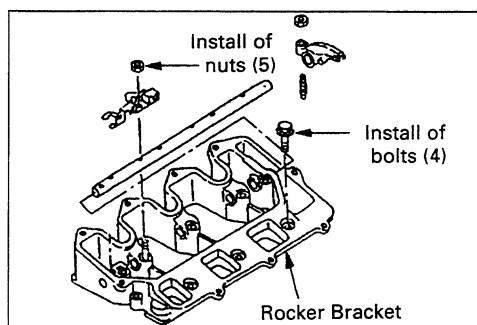


Fig. 47

**Rocker bracket****Push rod**

- (1) Remove the rocker bracket assembly.
(M6 × 1 4 bolts and 5 nuts)
- (2) Pull out the push rods (6 pcs.).

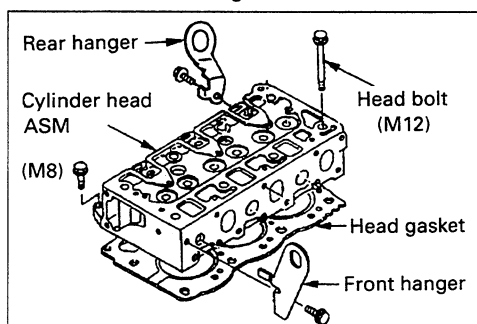


Fig. 48

**Cylinder head assembly**

- (1) Remove the rear and front hangers.
- (2) When removing the cylinder head bolts, loosen them slowly, a little at a time, starting with the outside, working in a circular pattern inward.
- (3) Remove the cylinder head assembly and the head gasket.
- (4) Pull out the tappet from the cylinder body.

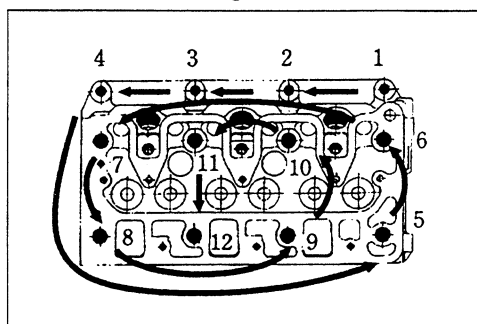


Fig. 49



Cylinder Head Assembly

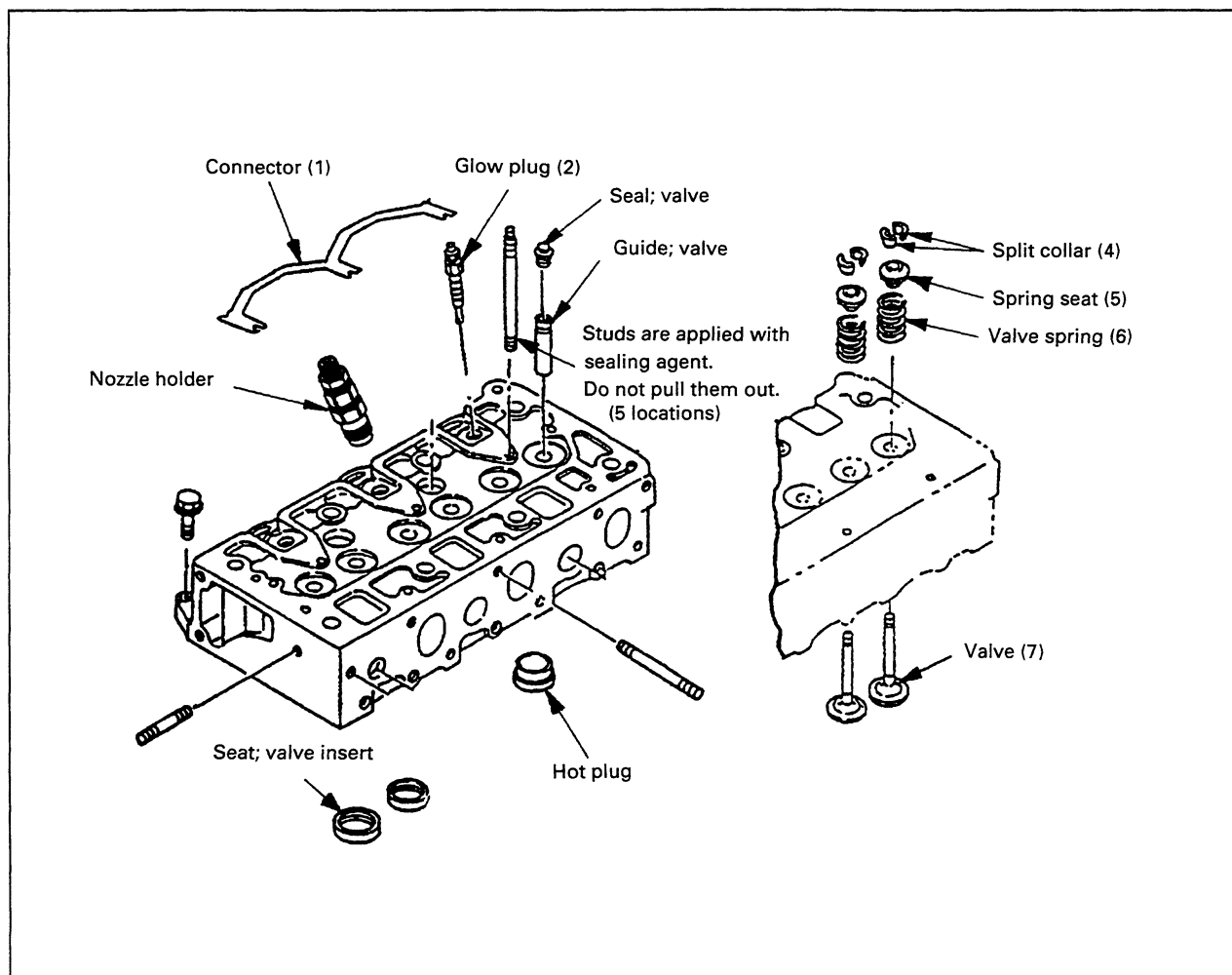


Fig. 50



Valve mechanism

- (1) Before disassembling the valve mechanism, remove the connector, glow plug and nozzle holder assembly.
- (2) Compressing the valve spring, remove the split collar, spring seat, valve spring and valve.



Timing Gear

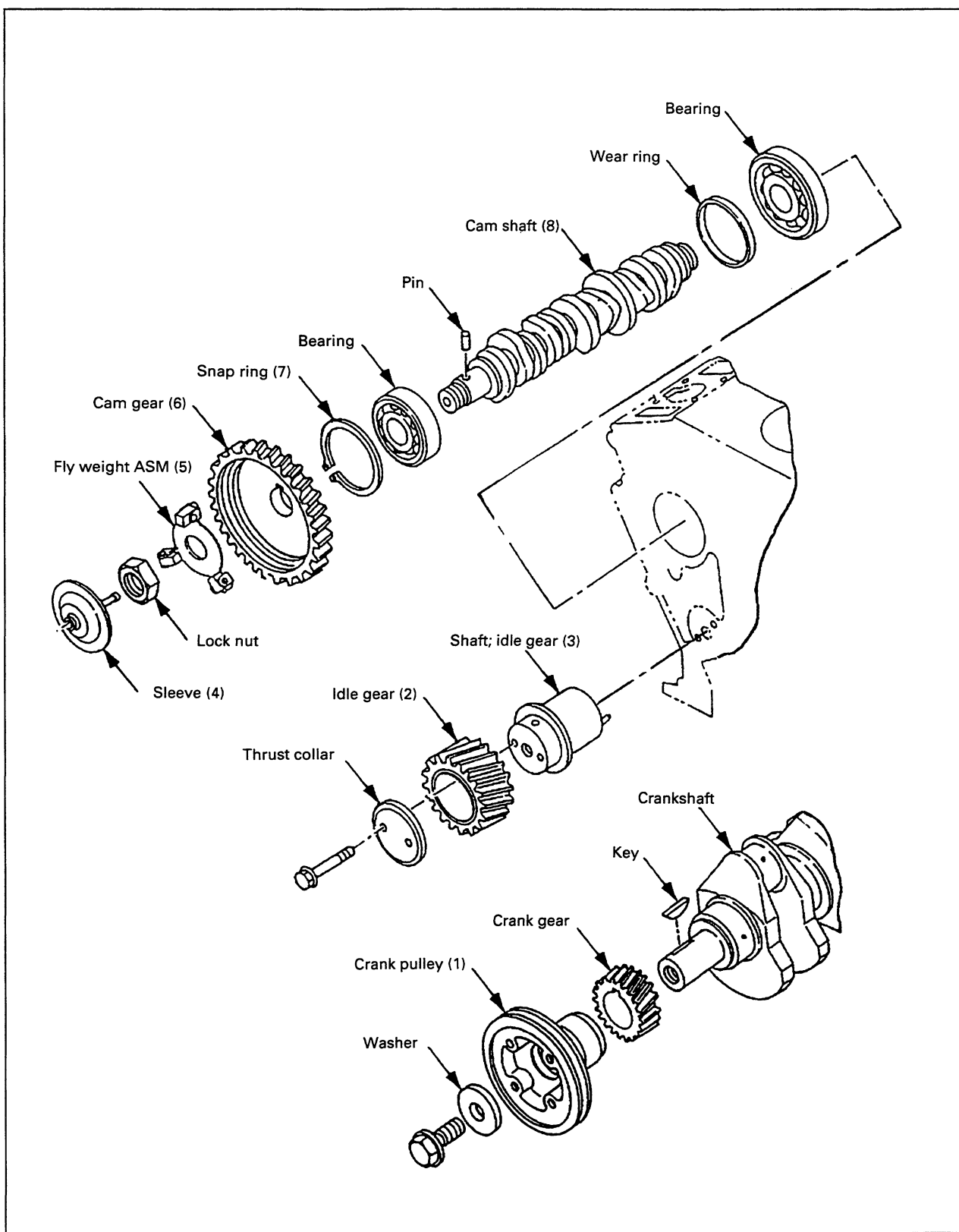


Fig. 51



Timing gear

- (1) Remove the idle gear and the idle gear shaft.
- (2) Pull out the sleeve from the tip end of the cam shaft.
- (3) Remove the lock nut of the cam shaft gear, and then remove the flyweight assembly and the cam gear.

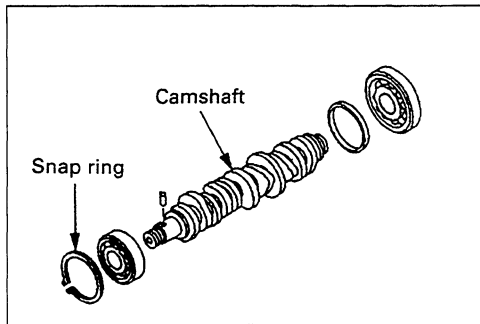


Fig. 52



Camshaft

- (1) Remove the snap ring which holds down the front bearing of the cam shaft from the ring groove of the cylinder block.
- (2) Pull out the cam shaft from the cylinder block, together with the bearing.



Piston and Connecting Rod

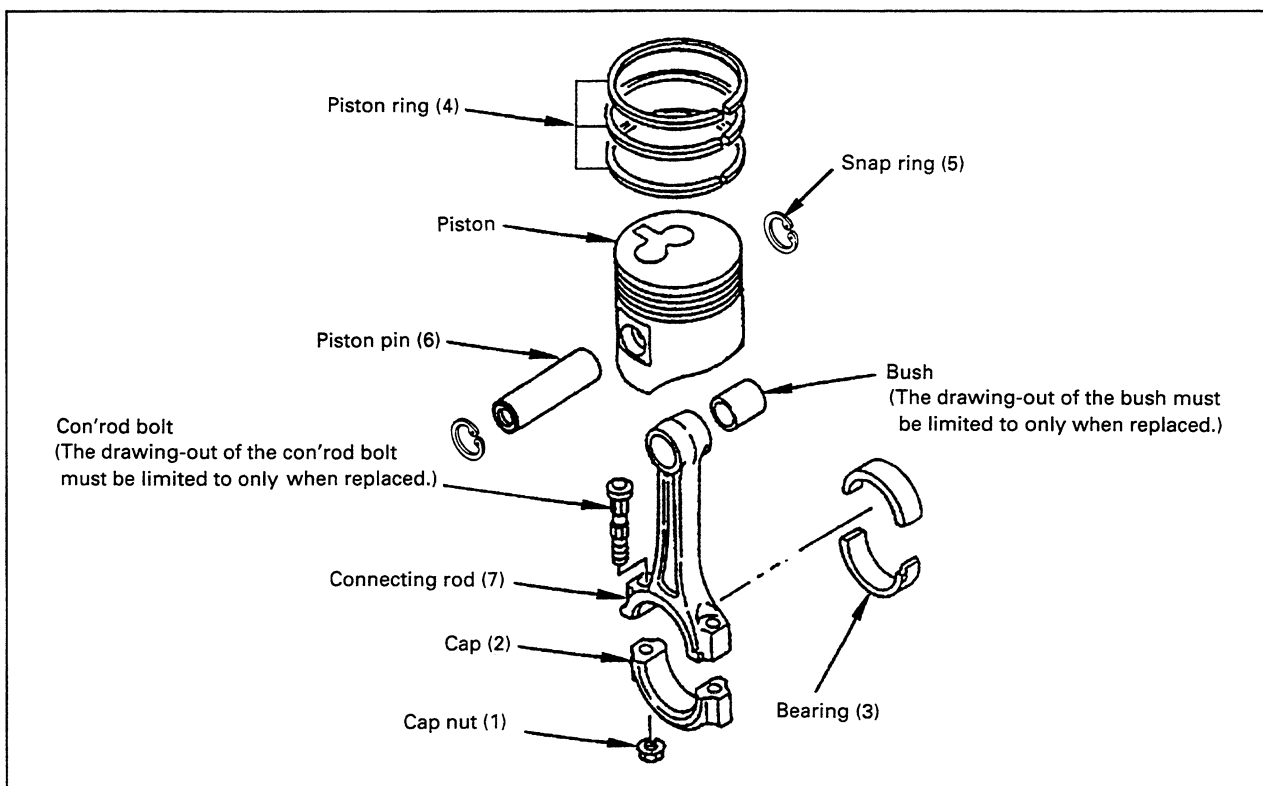


Fig. 53

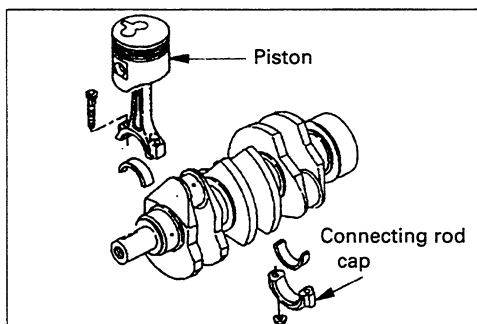


Fig. 54



Piston and connecting rod

- (1) Turning the crankshaft, position the piston to be removed at the bottom dead center.
- (2) Loosen the cap nut of the connecting rod, and then remove it.
- (3) Give another rotation to the crankshaft to position the piston at the top dead center.
- (4) With the handle of a hammer placed at the bottom of the connecting rod, push the piston assembly upward out of the cylinder block.

Notes:

1. **Before removing the piston, scrape the carbon deposit off the cylinder wall.**
2. **When pushing out the piston assembly, care should be taken not to damage the cylinder wall.**
3. **Attach a tag with a cylinder number to the removed caps and bearings to keep them in order.**

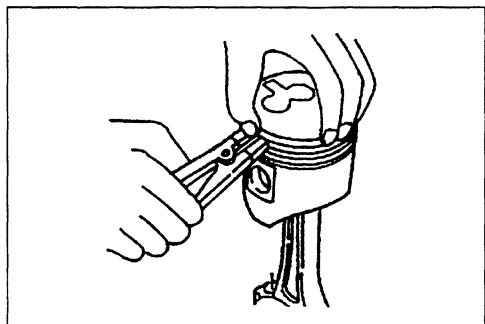


Fig. 55



Piston ring

Remove the piston ring with a ring pliers.



Pliers: piston ring 1-85221-029-0

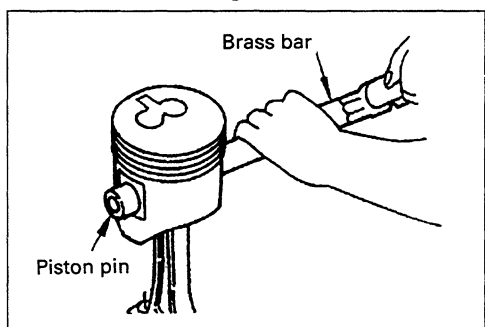


Fig. 56



Piston pin

- (1) Remove the snap rings with a commercially available tool.
- (2) With a brass bar attached to the piston pin, push it out by hammering it lightly.

Note:

Keep the pistons, piston pins and connecting rods in order for each cylinder.

INSPECTION AND REPAIR

Make the necessary adjustments, repairs, and part replacements if excessive wear or damage is discovered during inspection.

1. CYLINDER BLOCK

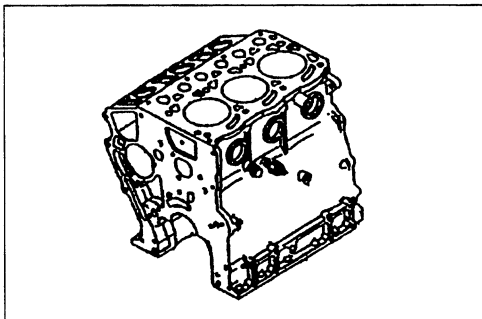


Fig. 57



Cylinder block

Check the cylinder block for wear, damage or any other defects.

Use the hydraulic gauge to check the water jacket water pressure.

Apply water pressure to the water jacket at 5 kg/cm² (71.1 psi) for three minutes.

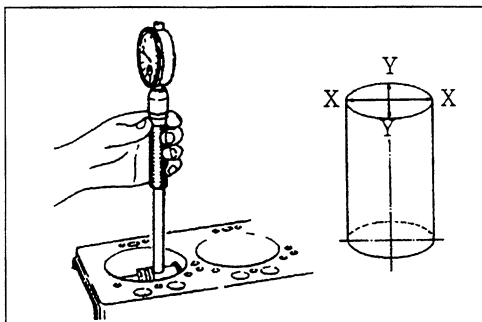


Fig. 58



Cylinder bore

Measurement position: 13mm below the top
(Measure in X-X and
Y-Y directions.)
(Near the No. 1
compression ring)

mm (in.)

| Engine | Limit | Repair method |
|----------------------|--------------|--------------------------------------------------|
| 3LA1 3LB1 3LD1 | 0.2 (0.0079) | Perform boring and honing of the inner diameter. |

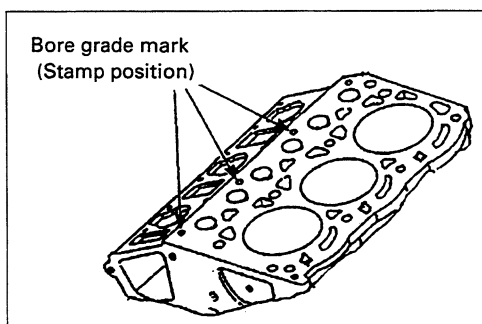


Fig. 59



Cylinder bore diameter and grade mark

The grade mark is stamped on the top surface of the cylinder block (on the mating face with the cylinder head).

| mm (in.) | | |
|----------|--------------------------------------|-------|
| Engine | Bore Diameter | Grade |
| 3LA1 | 70.000 – 70.010 (2.7559 – 2.7563) | A |
| | 70.011 – 70.020 (2.7563 – 2.7567) | B |
| | 70.021 – 70.030 (2.7567 – 2.7571) | C |
| 3LB1 | 77.400 – 77.410 (3.0472 – 3.0476) | A |
| | 77.411 – 77.420 (3.0476 – 3.0480) | B |
| | 77.421 – 77.430 (3.0480 – 3.0484) | C |
| 3LD1 | 83.100 – 83.110 (3.2716 – 3.2720) | A |
| | 83.111 – 83.120 (3.2720 – 3.2724) | B |
| | 83.121 – 83.130 (3.2724 – 3.2728) | C |

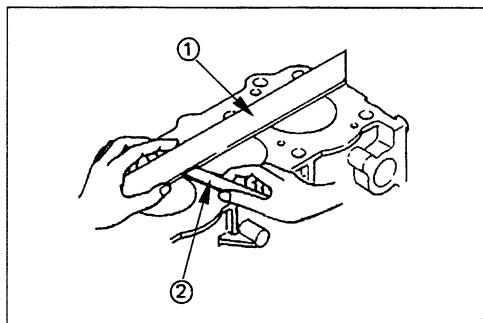


Fig. 60



Cylinder Body Upper Face Warpage

Use a straight edge ① and a feeler gauge ② to measure the four sides and the two diagonals of the cylinder body upper face.

Reground the cylinder body upper face if the measured values are greater than the specified limit but less than the maximum grinding allowance.

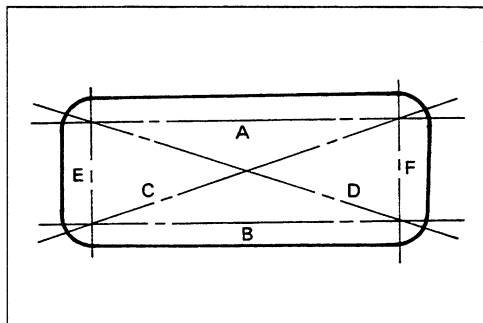


Fig. 61

If the measured values exceed the maximum grinding allowance, the cylinder body must be replaced.

Cylinder Body Upper Face Warpage

| mm (in.) | | |
|----------------|---------------|----------------------------|
| Standard | Limit | Maximum Grinding Allowance |
| 0.075 (0.0029) | 0.15 (0.0059) | 0.3 (0.0118) |

If the measured value is less than the limit, the cylinder body may be reground.

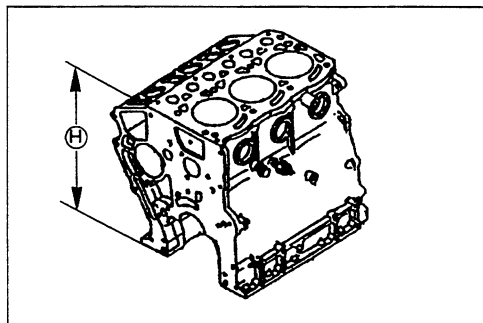


Fig. 62

Cylinder Body Height (H) (Reference)

| mm (in.) | | |
|--------------|---------------|-----------------|
| Engine | Standard | Limit |
| 3LA1 3LB1 | 281 (11.0630) | 280.7 (11.0512) |
| 3LD1 | 308 (12.1260) | 307.7 (12.1142) |

2. CYLINDER HEAD

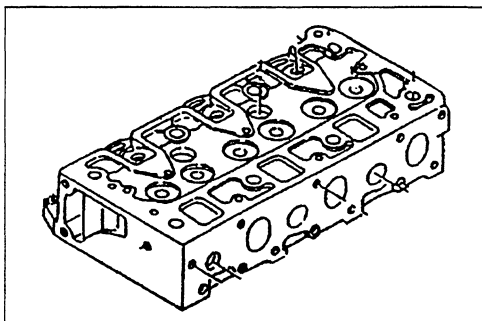


Fig. 63



Cylinder head inspection

Remove carbon deposit on the bottom surface of the head with care not to damage the valve seat.

Leakage: Water pressure test 5kg/cm² (for 3 minutes)

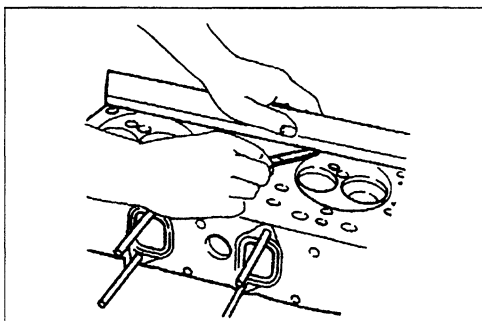


Fig. 64



Cylinder Head Lower Face Warpage

1. Use a straight edge and a feeler gauge to measure the four sides and the two diagonals of the cylinder head lower face.
2. Regrind the cylinder head lower face if the measured values are greater than the specified limit but less than the maximum grinding allowance.

If the measured values exceed the maximum grinding allowance, the cylinder head must be replaced.

Cylinder Head Lower Face Warpage mm (in.)

| Standard | Limit | Maximum Grinding Allowance |
|----------------|---------------|----------------------------|
| 0.075 (0.0029) | 0.15 (0.0059) | 0.3 (0.0118) |

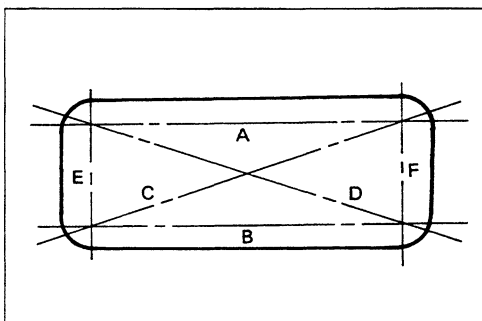


Fig. 65

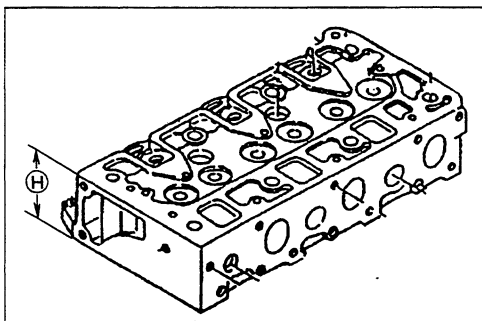


Fig. 66



Cylinder Head Height (H) (Reference) mm (in.)

| Standard (H) | Limit |
|--------------|---------------|
| 64 (2.5197) | 63.7 (2.5079) |

Note:

If the cylinder head lower face is reground, valve depression must be checked.

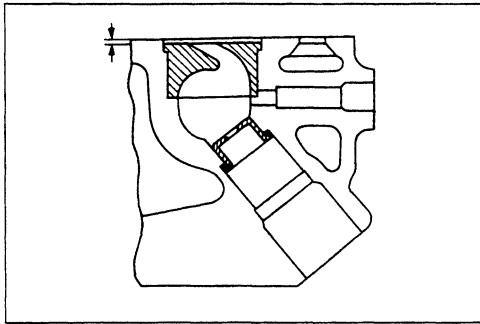


Fig. 67

**HOT PLUG****Hot Plug Depression**

1. Clean the cylinder head lower face, taking care not to damage the hot plug surfaces.
2. Use a straight edge and a feeler gauge to measure the hot plug depression in a straight line from the No. 1 hot plug to the No. 3 hot plug.

If the measured value exceeds the specified limit, the hot plugs must be replaced.

Hot Plug Depression mm (in.)

| Limit |
|--------------|
| 0.05 (0.002) |

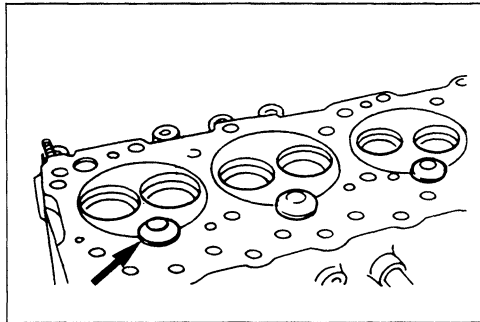


Fig. 68

**Combustion Chamber Inspection**

1. Remove the carbon adhering to the inside of the combustion chamber. Take care not to damage the hot plug fitting positions.
2. Inspect the combustion chamber, the hot plug hole, and the hot plug machined faces for cracking and other damage.

If cracking or damage is present, the cylinder head must be replaced.

Note:

Be absolutely certain that there are no scratches or protuberances on the combustion chamber surfaces which will be in contact with the hot plug after it is installed. These flaws will prevent the hot plug from seating correctly.

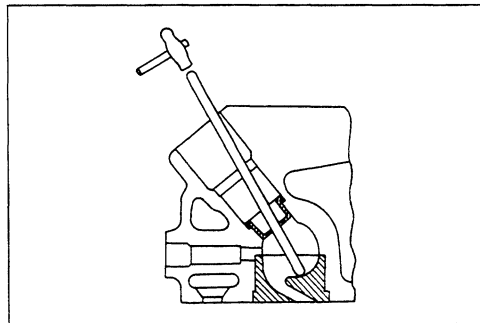


Fig. 69

**Hot Plug Replacement****Hot Plug Removal**

1. Insert a 3.0 – 5.0 mm (0.12 – 0.20 in) diameter brass bar into the nozzle holder fitting hole until it makes contact with the hot plug.
2. Lightly tap the bar with a hammer to drive the hot plug free.

**Hot Plug Inspection**

Inspect the hot plugs for excessive wear and other damage. Replace the hot plugs if either of these conditions are discovered.

Refer to "Hot Plug Installation".

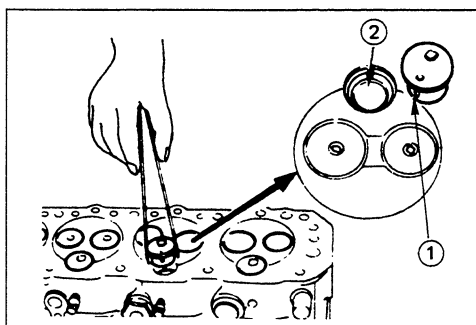


Fig. 70

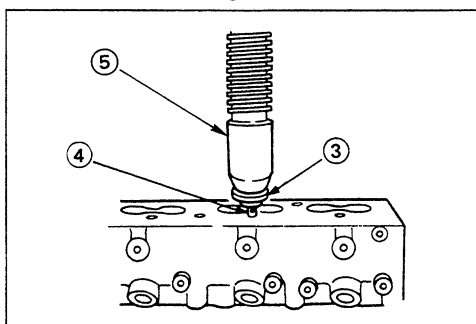


Fig. 71

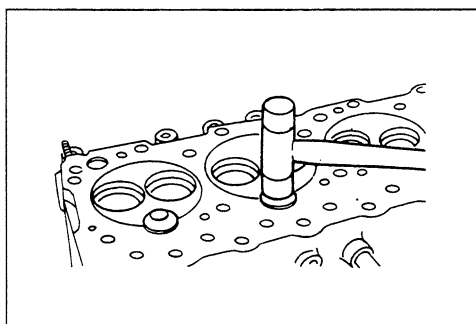


Fig. 72

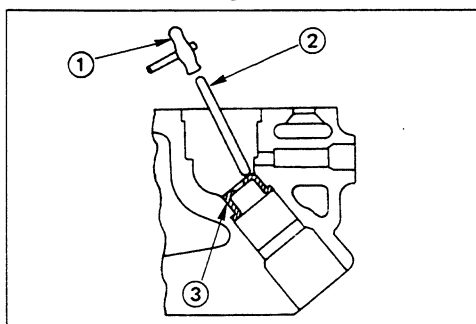


Fig. 73



Hot Plug Installation

1. Align the hot plug knock ball ① with the cylinder head groove ② and tap it temporarily into position with a plastic hammer.
2. Place a metal plate ③ approximately 25 mm (1 in) thick over the hot plug upper surface ④.
3. Use a bench press ⑤ to exert a pressure of 4,000 – 5,000 kg (8,819 – 11,023 lb/39,227 – 49,033 N) on the metal plate covering the hot plug upper surface. This will drive the hot plug into position.
4. Lightly tap the hot plug head to make sure that it is firmly seated.
5. Repeat the procedure (Steps 1 – 4) for the remaining hot plugs.

Note:

Do not apply pressure greater than that specified. Damage to the cylinder head will result.

6. Use a surface grinder to grind off any hot plug surface protuberances.
The hot plug surfaces must be perfectly flush with the cylinder head lower face.
7. After grinding, make sure that the hot plug surfaces are completely free of protuberances.
The hot plug surfaces must also be free of depressions.
Once again, lightly tap the hot plug heads to make sure that they are firmly seated.



Heat Shield Replacement

Heat Shield Removal

After removing the hot plugs, use a hammer ① and a brass bar ② to lightly tap the lower side of the heat shield ③ and drive it free.

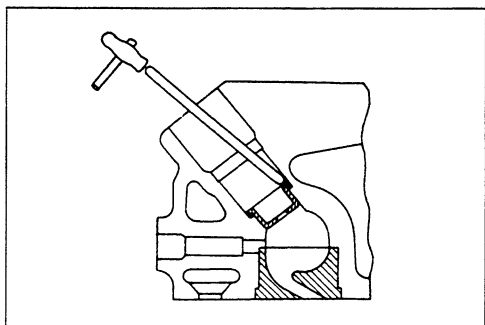


Fig. 74

**Heat Shield Installation**

Install the heat shield to the cylinder head from the nozzle holder installation hole side. Lightly tap the heat shield flange into place with a hammer and a brass bar.

The heat shield flange side must be facing up.

Note:

Always install a new heat shield. Never reuse the old heat shield.

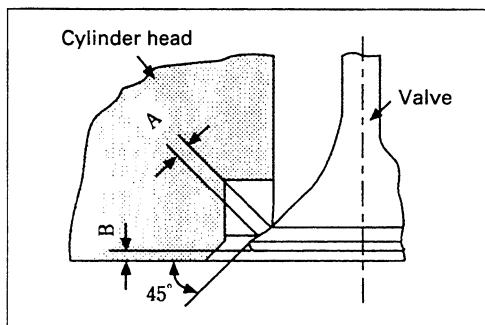
**3. VALVE, VALVE SEAT INSERT AND VALVE SEAL**

Fig. 75

**Inspection of valve seat**

1. A – Contact width
2. B – Valve depression

mm (in.)

| | Standard | Limit |
|------------------|--------------|--------------|
| Contact width | 2.0 (0.0787) | 2.5 (0.0984) |
| Valve depression | 0.7 (0.0276) | 1.2 (0.0427) |

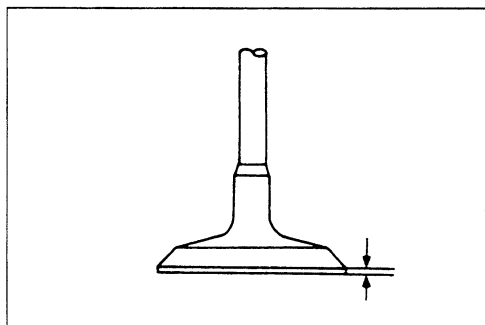


Fig. 76

**Valve thickness**

| Nominal | Limit | Repair method |
|------------------|-----------------|---------------|
| 1.0 (0.03937) | 0.7 (0.0276) | Replace |

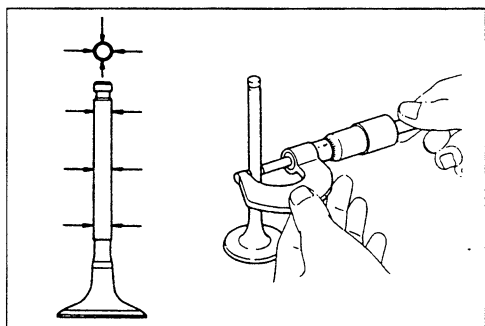


Fig. 77

**Valve Stem Outside Diameter**

Measure the valve stem diameter at three points.

If the measured value is less than the specified limit, the valve must be replaced.

Valve Stem Outside Diameter mm (in.)

| | Standard | Limit |
|---------------|-----------------|------------------|
| Intake Valve | 7.0 (0.2756) | 6.85 (0.2697) |
| Exhaust Valve | 7.0 (0.2756) | 6.80 (0.2677) |

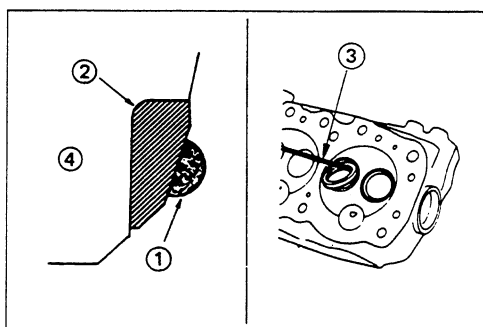


Fig. 78

**Valve Seat Insert Replacement****Valve Seat Insert Removal**

1. Arc weld the entire inside circumference ① of the valve seat insert ②.
2. Allow the valve seat insert to cool for a few minutes. This will invite contraction and make removal of the valve seat insert easier.
3. Use a screwdriver ③ to pry the valve seat insert free.
Take care not to damage the cylinder head ④.
4. Carefully remove carbon and other foreign material from the cylinder head insert bore.

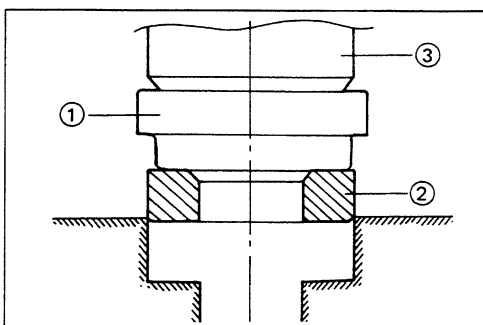


Fig. 79

**Valve Seat Insert Installation**

1. Carefully place the attachment ① (having a smaller outside diameter than the valve seat insert) on the valve seat insert ②.

**Note:**

The smooth side of the attachment must contact the valve seat insert.

2. Use a bench press ③ to gradually apply pressure to the attachment and press the valve seat insert into place. 4,000 kg (8,819 lbs.)

Note:

Do not apply an excessive amount of pressure with the bench press. Damage to the valve seat insert will result.

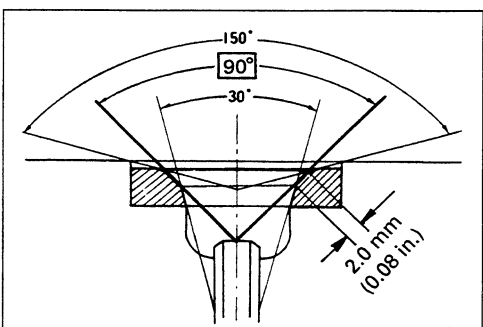


Fig. 80

**Valve Seat Insert Correction**

1. Remove the carbon from the valve seat insert surface.
2. Use a valve cutter (15°, 45°, and 75° blades) to minimize scratches and other rough areas. This will bring the contact width back to the standard value.
Remove only the scratches and rough areas. Do not cut away too much. Take care not to cut away unblemished areas of the valve seat surface.

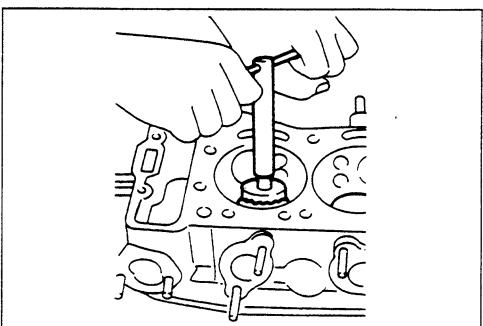


Fig. 81

**Valve Seat Angle**

degree

45

Note:

Use an adjustable valve cutter pilot.

Do not allow the valve cutter pilot to wobble inside the valve guide.

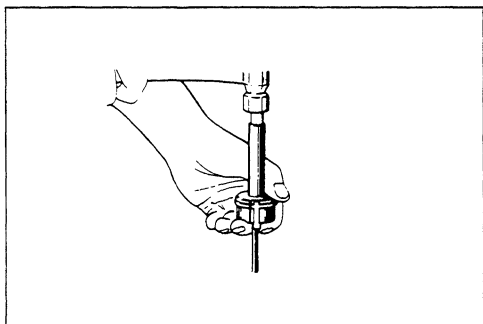


Fig. 82

3. Apply abrasive compound to the valve seat insert surface.
4. Insert the valve into the valve guide.
5. Apply light pressure to the valve while turning it to fit the valve seat insert.
6. Check that the valve contact width is correct.
7. Check that the valve seat insert surface is in contact with the entire circumference of the valve.
8. Clean the head and valves to remove the abrasive compound and metal particles.

4. VALVE SPRING

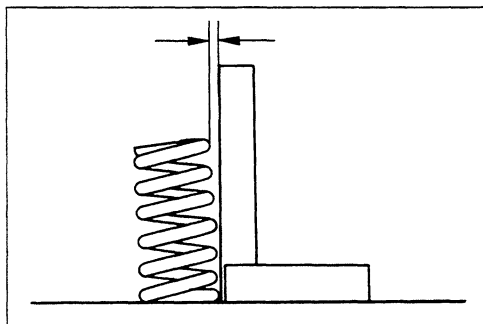


Fig. 83



Valve Spring Inclination

Use a surface plate and a square to measure the valve spring inclination.

If the measured value exceeds the specified limit, the valve spring must be replaced.

| | mm (in.) | |
|--------------------------|-----------------|-----------------|
| | Standard | Limit |
| Valve Spring Inclination | 1.8 (0.0709) | 2.5 (0.0984) |

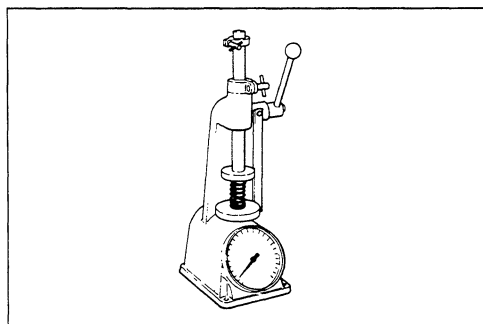


Fig. 84



Valve Spring Tension

Use a spring tester to measure the valve spring tension.

If the measured value is less than the specified limit, the valve spring must be replaced.

| | mm (in.) | |
|-------------------------------------------|------------------|------------------|
| | Standard | Limit |
| Valve Spring Tension at 29.9mm Set Length | 17.0 (0.6693) | 15.0 (0.5905) |

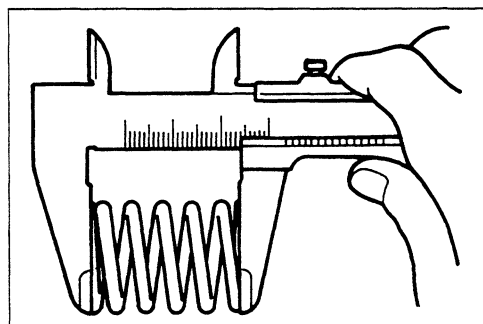


Fig. 85



Valve Spring Free Length

Use a vernier caliper to measure the valve spring free length.

If the measured value is less than the specified limit, the valve spring must be replaced.

| | mm (in.) | |
|---------------------------------------------|------------------|------------------|
| | Standard | Limit |
| Exhaust and Intake Valve Spring Free Length | 42.1 (1.6575) | 40.0 (1.5748) |

5. TAPPET (Cam Follower or Valve Lifter) AND PUSH ROD



TAPPET

Inspect the tappets for excessive wear, damage and any abnormalities.



Use a micrometer to measure the tappet diameter.

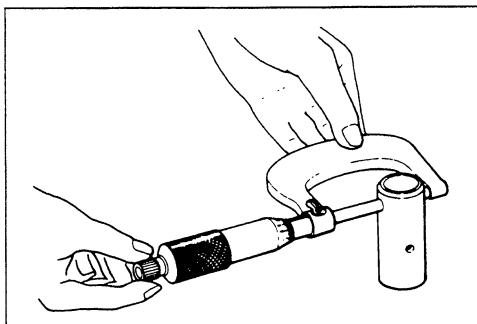


Fig. 86

mm (in.)

| | Standard |
|-----------------|----------------------------------------|
| Tappet Diameter | 20.967 – 20.980 (0.82547 – 0.82598) |



Use a dial indicator to measure the clearance between the tappet and cylinder body tappet travelling bore.

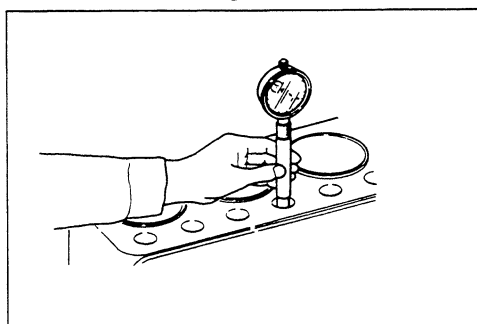


Fig. 87

mm (in.)

| | Standard | Limit |
|---------------------------------------------|--------------------------------------|-------------------|
| Tappet and Tappet Travelling Bore Clearance | 0.020 – 0.054 (0.00079 – 0.00213) | 0.08 (0.00315) |



PUSH ROD

Use a filler gauge to measure the valve push rod runout. Roll the push rod along a smooth flat surface (illustration).

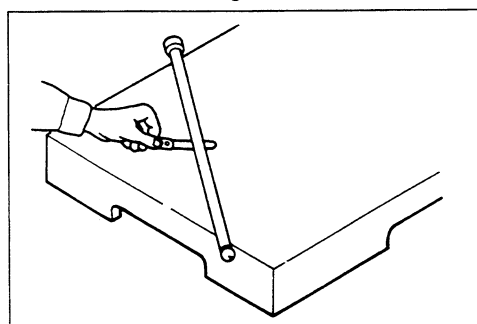


Fig. 88

mm (in.)

| | Limit |
|------------------|--------------|
| Push Rod Run-Out | 0.3 (0.0118) |

6. CAM SHAFT

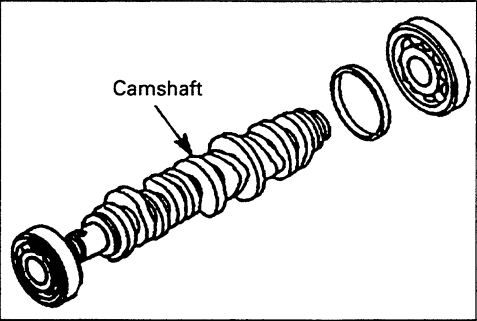


Fig. 89

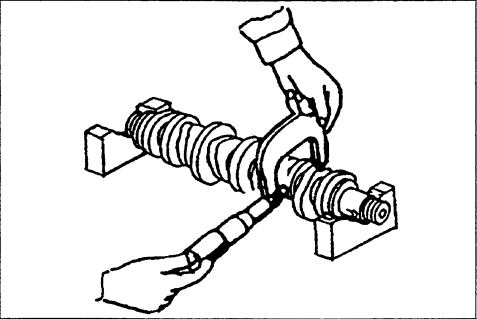


Fig. 90

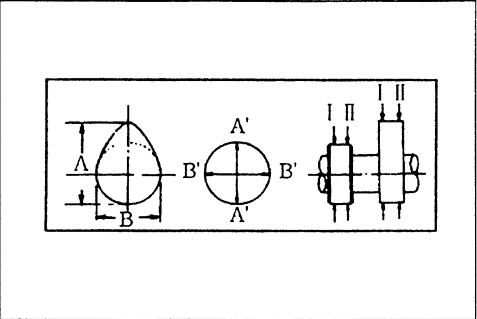


Fig. 91

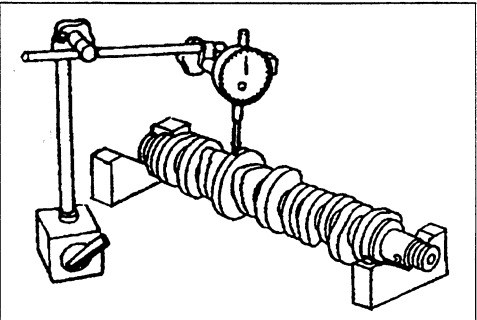


Fig. 92



Inspection of cam shaft

Check the journal and the cam for evidence of wear, damage or any other defect.

Note:

With the front and rear parts of camshaft pressed in with ball bearings, and with the cylinder block pressed in with roller bearings as the center bearing, check to see if the camshaft rotates smoothly with no play at each bearing.



Measurement of journal and cam

(1) Cam height (A – B) mm (in.)

| | | Standard | Limit | Repair method |
|---------|------|------------------|------------------|---------------|
| Intake | 3LA1 | 5.98 (0.2354) | 5.68 (0.2236) | Replace |
| | 3LB1 | | | |
| | 3LD1 | | | |
| Exhaust | All | 6.23 (0.2453) | 5.98 (0.2354) | Replace |

(2) Center journal diameter mm (in.)

| Nominal | Limit | Repair method |
|-----------------------|--------------------------|---------------|
| 55 ϕ (2.1654) | 54.92 ϕ (2.1622) | Replace |

(3) Uneven wear of journal mm (in.)

| Nominal | Limit | Repair method |
|-----------------------|--------------|---------------|
| 55 ϕ (2.1654) | 0.05 (0.002) | Replace |

(4) Runout of cam shaft mm (in.)

| Nominal | Limit | Repair method |
|-----------------|-------------|---------------|
| 0.02 (0.008) | 0.1 (0.004) | Replace |



7. ROCKER ARM SHAFT AND ROCKER ARM

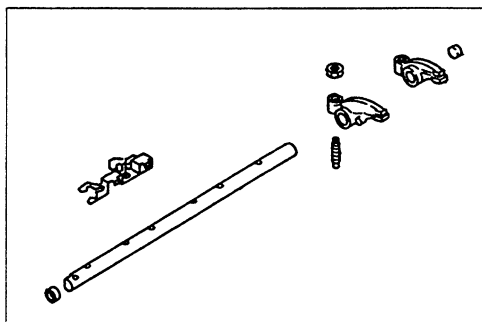


Fig. 93



Inspect all disassembled parts for wear, damage and any abnormalities.

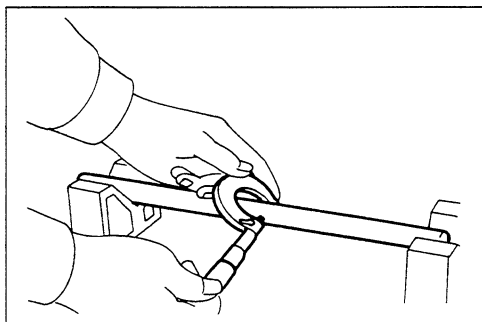


Fig. 94

Rocker Arm Shaft Outside Diameter



Use a micrometer to measure the rocker arm outside diameter.

If the measured value is less than the specified limit, the shaft must be replaced.

mm (in.)

| | Standard |
|---------------------------|--------------------------------------|
| Rocker Arm Shaft Diameter | 11.935 – 11.955 (0.4699 – 0.4707) |

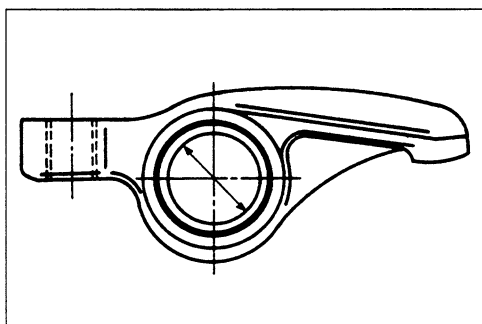


Fig. 95



Rocker Arm Shaft and Rocker Arm Clearance

1. Use a vernier caliper to measure the rocker arm bushing inside diameter.

mm (in.)

| | Standard |
|------------------------------------|--------------------------------------|
| Rocker Arm Bushing Inside Diameter | 11.960 – 11.980 (0.4709 – 0.4717) |

2. Measure the rocker arm shaft outside diameter.
Replace either the rocker arm or the rocker arm shaft if the clearance exceeds the specified limit.

mm (in.)



| | Standard | Limit |
|---------------------------------------------------|------------------------------------|-----------------|
| Rocker Arm Bushing and Rocker Arm Shaft Clearance | 0.005 – 0.045 (0.0002 – 0.0018) | 0.2 (0.0079) |

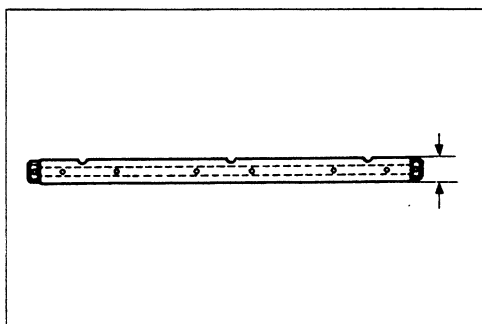


Fig. 96

3. Check that the rocker arm oil port is free of obstructions.

If necessary, use compressed air to clean the rocker arm oil port.

8. PISTON, PISTON PIN AND PISTON RING

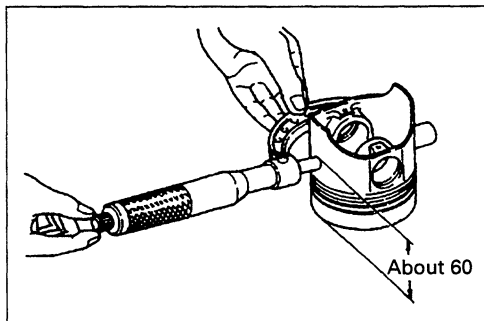


Fig. 97



Clearance between piston and cylinder bore

- (1) Measure the outside diameter of the piston at about 60 mm from the top in a right angle to the piston pin (in the unit of 1/1,000 mm).
- (2) Calculate the clearance based on the measurements of the cylinder bore and the outside diameter of the piston.

mm (in.)

| | |
|-----------|---------------------------------|
| Clearance | 0.015 – 0.035 (0.0006 – 0.0014) |
|-----------|---------------------------------|

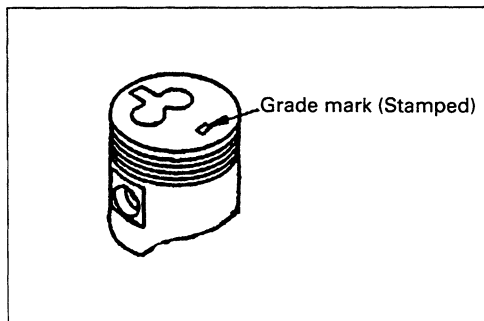


Fig. 98



Outside diameter of piston and grade mark

The grade mark is stamped on the top surface of the piston.

mm (in.)

| Model | Outside diameter of piston | Grade | Service parts grade |
|-------|--------------------------------------|-------|---------------------|
| 3LA1 | 69.975 – 69.985 (2.7549 – 2.7553) | A | Ⓐ |
| | 69.986 – 69.995 (2.7553 – 2.7557) | B | |
| | 69.996 – 70.005 (2.7557 – 2.7561) | C | |
| 3LB1 | 77.375 – 77.385 (3.0463 – 3.0467) | A | Ⓐ |
| | 77.386 – 77.395 (3.0467 – 3.0471) | B | |
| | 77.396 – 77.405 (3.0471 – 3.0475) | C | |
| 3LD1 | 83.075 – 83.085 (3.2707 – 3.2711) | A | Ⓐ |
| | 83.086 – 83.095 (3.2711 – 3.2715) | B | |
| | 83.096 – 83.105 (3.2715 – 3.2719) | C | |

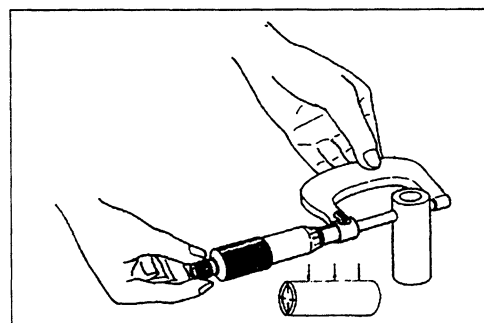


Fig. 99



Wear of piston pin (outside diameter)

mm (in.)

| Model | Nominal | Limit | Remarks |
|--------------|------------------|-------------------|------------------------------|
| 3LA1 3LB1 | 21.0 (0.8268) | 20.97 (0.8256) | Replace if worn beyond limit |
| 3LD1 | 25.0 (0.9843) | 24.97 (0.9831) | |

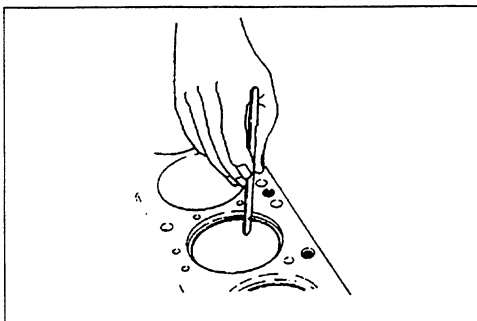


Fig. 100

**Clearance between piston pin and piston pin hole**

mm (in.)

| | Standard |
|------------------|--------------------------------------|
| 3LA1, 3LB1, 3LD1 | 0.002 – 0.012 (0.00008 – 0.00047) |

**Piston ring gap**

With the ring inserted into the cylinder bore, push it in with the piston head so that it becomes a right angle to the cylinder, and then measure the gap of the piston ring.

If worn beyond the limit, replace the rings.

mm (in.)

| | | Standard | Limit |
|----------------------|--------------|---------------------------------|------------------|
| 1st compression ring | | 0.2 – 0.35 (0.0079 – 0.0138) | 2.0 (0.07874) |
| 2nd compression ring | 3LA1 3LB1 | 0.2 – 0.4 (0.0079 – 0.0157) | |
| | 3LD1 | 0.35 – 0.5 (0.0138 – 0.0197) | |
| Oil ring | | 0.2 – 0.4 (0.0079 – 0.0157) | 1.0 (0.03937) |

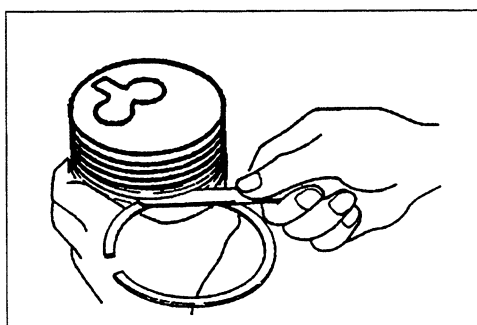


Fig. 101

**Clearance between piston ring groove and ring**

Measure clearance at several places on the circumference.

If worn beyond the limit, replace the rings or piston.

3LA1

mm (in.)

| | Standard | Limit |
|----------------------|-----------------------------------|------------------|
| 1st compression ring | 0.065 – 1.0 (0.0026 – 0.0039) | 0.3 (0.0012) |
| 2nd compression ring | 0.03 – 0.065 (0.0012 – 0.0026) | |
| Oil ring | 0.02 – 0.06 (0.0008 – 0.0024) | 0.15 (0.0059) |

3LB1

mm (in.)

| | Standard | Limit |
|----------------------|----------------------------------|------------------|
| 1st compression ring | 0.065 – 1.0 (0.0026 – 0.0039) | 0.3 (0.0012) |
| 2nd compression ring | 0.03 – 0.07 (0.0012 – 0.0026) | |
| Oil ring | 0.02 – 0.06 (0.0008 – 0.0024) | 0.15 (0.0059) |

3LD1 mm (in.)

| | Standard | Limit |
|----------------------|------------------------------------|------------------|
| 1st compression ring | 0.085 – 0.105 (0.0033 – 0.0041) | 0.3 (0.0012) |
| 2nd compression ring | 0.05 – 0.085 (0.002 – 0.0033) | |
| Oil ring | 0.03 – 0.07 (0.0012 – 0.0028) | 0.15 (0.0059) |

**Piston ring tension**

3LA1 kg (lb.)

| | Standard | Limit |
|----------------------|--------------------------------|----------------|
| 1st compression ring | 1.04 – 1.5 (2.293 – 3.306) | 0.4 (0.882) |
| 2nd compression ring | 0.75 – 1.15 (1.654 – 2.536) | 0.3 (0.662) |
| Oil ring | 2.1 – 3.7 (4.631 – 8.159) | 0.6 (1.323) |

3LB1 kg (lb.)

| | Standard | Limit |
|----------------------|--------------------------------|----------------|
| 1st compression ring | 1.07 – 1.53 (2.359 – 3.374) | 0.4 (0.882) |
| 2nd compression ring | 0.77 – 1.17 (1.698 – 2.58) | 0.3 (0.662) |
| Oil ring | 2.4 – 3.7 (5.292 – 8.159) | 0.6 (1.323) |

3LD1 kg (lb.)

| | Standard | Limit |
|----------------------|--------------------------------|----------------|
| 1st compression ring | 1.14 – 1.62 (2.514 – 3.572) | 0.6 (1.323) |
| 2nd compression ring | 0.99 – 1.43 (2.183 – 3.153) | |
| Oil ring | 2.5 – 4.0 (5.513 – 8.82) | 1.8 (3.969) |

9. CONNECTING ROD AND CONNECTING ROD BEARING

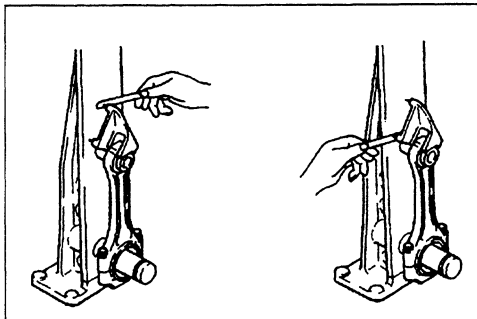


Fig. 102



Torsion and parallelism of connecting rod

If worn beyond the limit-repair or replace.

mm (in.)

| Per 100 mm (3.94) | Standard | Limit |
|-------------------|-----------------|------------------|
| Torsion | 0.05 (0.002) | 0.2 (0.0079) |
| Parallelism | 0.05 (0.002) | 0.15 (0.0059) |



Clearance between small end pin hole of connecting rod and piston pin, inside diameter of bushing

mm (in.)

| | | Standard | Limit |
|-----------------|--------------|------------------------------------|------------------|
| Clearance | | 0.008 – 0.020 (0.0003 – 0.0008) | 0.05 (0.0020) |
| Inside diameter | 3LA1 3LB1 | 21 (0.8268) | — |
| | 3LD1 | 25 (0.9843) | — |

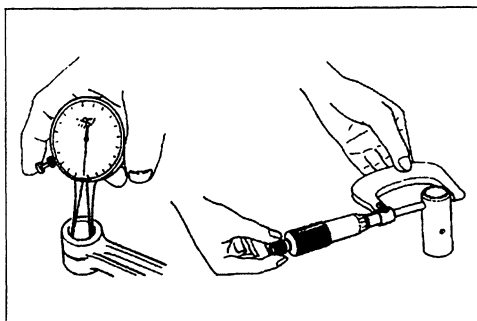


Fig. 103



Connecting Rod Bearing Inspection

1. Fit the connecting rod bearing lower half into the connecting rod bearing cap.
2. Check the connecting rod bearing lower half tension. If the tension is insufficient, the bearing must be replaced.
3. Tighten the connecting rod and the bearing cap to the specified torque.

kg·m (lb. ft.)

| | | |
|-------------------|------|------------------------|
| Tightening torque | 3LA1 | 3.8 – 4.2 (27 – 30) |
| | 3LB1 | |
| | 3LD1 | 7.5 – 8.5 (54 – 61) |

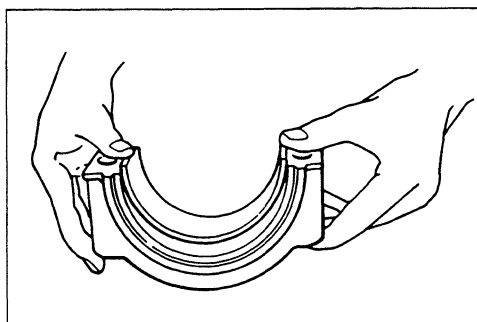


Fig. 104



Clearance between bearing and crank pin, inside diameter with bearing installed and without.

mm (in.)

| | | Standard | Limit |
|----------------------|--------------|------------------------------------|------------------|
| Clearance | | 0.035 – 0.073 (0.0014 – 0.0029) | 0.12 (0.0047) |
| I.D. with bearing | 3LA1 3LB1 | 43 (1.6929) | — |
| | 3LD1 | 49 (1.9291) | — |
| I.D. without bearing | 3LA1 3LB1 | 46 (1.8110) | — |
| | 3LD1 | 52 (2.0472) | — |

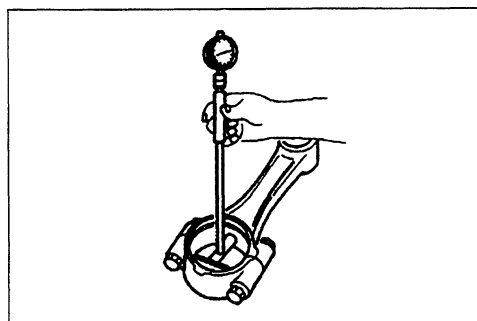


Fig. 105



10. CRANKSHAFT AND CRANKSHAFT BEARING

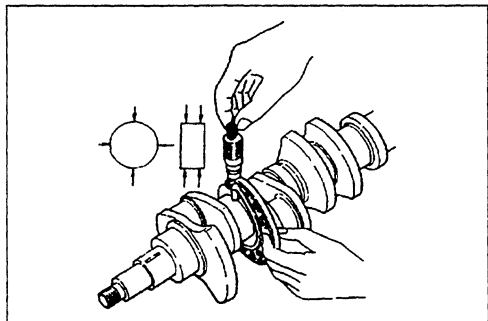


Fig. 106

**Outside diameters of journal and pin**

If worn beyond the limits-replace



Crank journal mm (in.)



| | Standard | Limit |
|--------------|---------------|----------------|
| 3LA1 3LB1 | 52.0 (2.0472) | 51.86 (2.0417) |
| 3LD1 | 60.0 (2.3622) | 59.86 (2.3567) |

Crank pin mm (in.)

| | Standard | Limit |
|--------------|---------------|----------------|
| 3LA1 3LB1 | 43.0 (1.6929) | 42.87 (1.6878) |
| 3LD1 | 49.0 (1.9291) | 48.87 (1.9240) |

Note:

When there occurs an uneven wear to the crankshaft, replace it with a new one without grinding it for reuse.

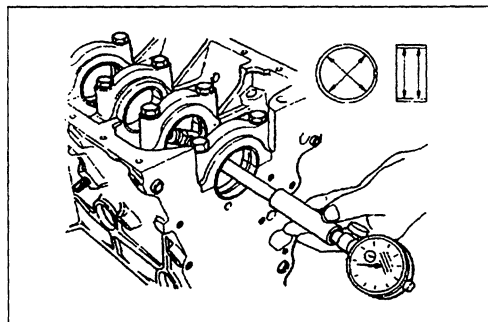


Fig. 107

**Clearance between journal and bearing inside diameter with bearing installed and without**

mm (in.)



| | | Standard | Limit |
|----------------------|--------------|------------------------------------|------------------|
| Clearance | | 0.029 – 0.072 (0.0011 – 0.0028) | 0.12 (0.0005) |
| I.D. with bearing | 3LA1 3LB1 | 52 (2.0472) | — |
| | 3LD1 | 60 (2.3622) | — |
| I.D. without bearing | 3LA1 3LB1 | 56 (2.2047) | — |
| | 3LD1 | 64 (2.5197) | — |

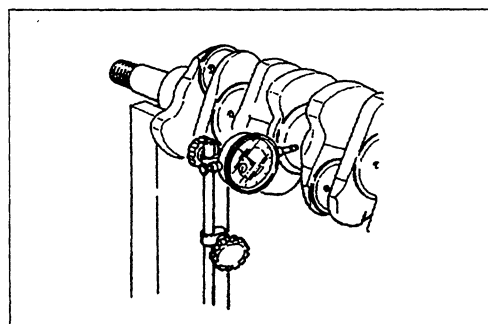


Fig. 108

**Runout of crankshaft**

Replace if beyond limit

mm (in.)

| Standard | Limit |
|---------------|--------------|
| 0.025 (0.001) | 0.05 (0.002) |

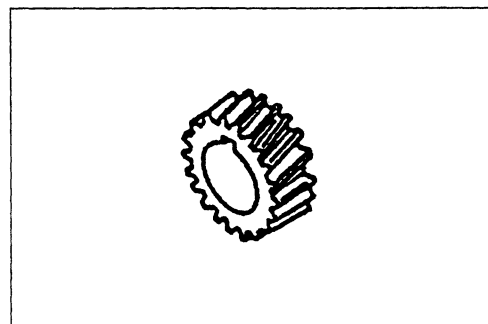


Fig. 109

**Crankshaft gear**

Check the crankshaft gear visually for damage and any other defects.



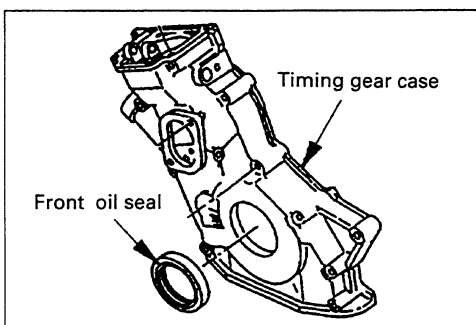


Fig. 110

11.FLYWHEEL AND RING GEAR

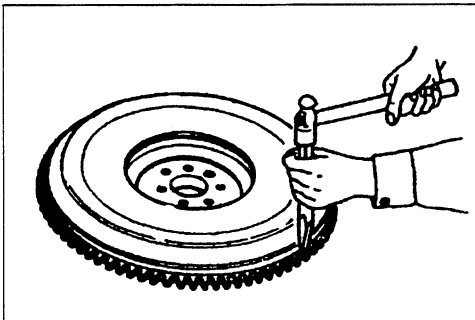


Fig. 111

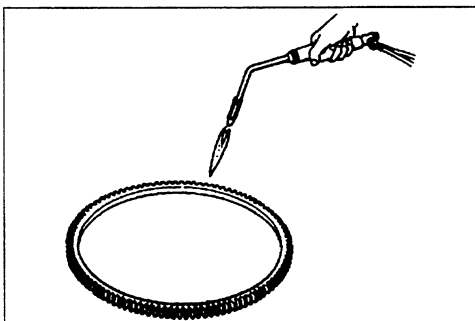


Fig. 112

12.TIMING GEAR

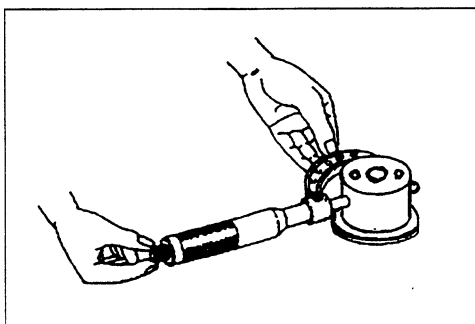


Fig. 113

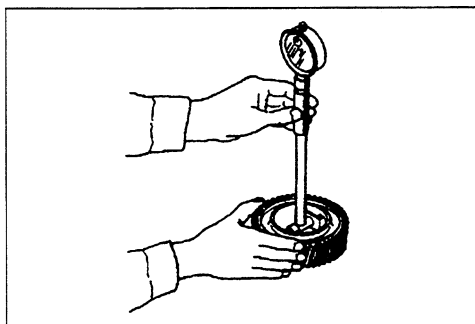


Fig. 114



Oil seal

When the lip of an oil seal is found defective, replace it with a new one.



Installation

Use the crankshaft front oil seal installer to install the crankshaft front oil seal.



Ring Gear Replacement

Ring Gear

Inspect the ring gear.

If the ring gear teeth are broken or excessively worn, the ring gear must be replaced.



Ring Gear Removal

Strike around the edges of the ring gear with a hammer and chisel to remove it.



Ring Gear Installation

1. Heat the ring gear evenly with a gas burner to invite thermal expansion.

Do not allow the temperature of the gas burner to exceed 200°C (390°F).

2. Use a hammer to install the ring gear when it is sufficiently heated.



Uneven wear of idle gear shaft

mm (in.)



| Nominal | Limit |
|---------------|--------------|
| 45.0 (1.7717) | 0.1 (0.0039) |



Clearance between idle gear bushing and shaft

mm (in.)



| Standard | Limit |
|--------------------------------|--------------|
| 0.025 – 0.085 (0.001 – 0.0033) | 0.2 (0.0079) |



REASSEMBLY

1. CYLINDER HEAD ASSEMBLY

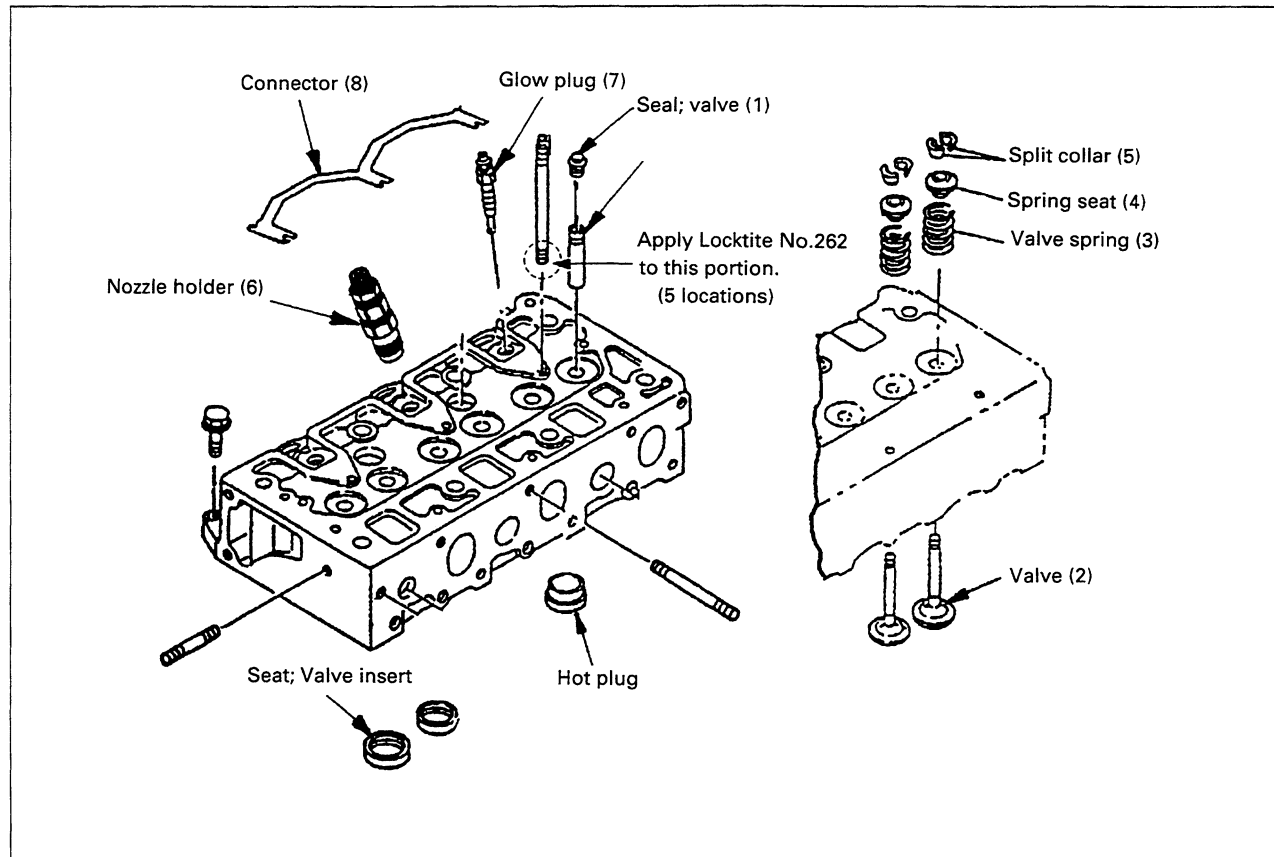


Fig. 115



Important Operations



Valve Stem Oil Seal

- 1) Lubricate the oil seals and valve stem sealing area with engine oil.
- 2) Use a valve stem oil seal installer to install the oil seal.

Valve Stem Oil Seal Installer: 5-8840-9007-0

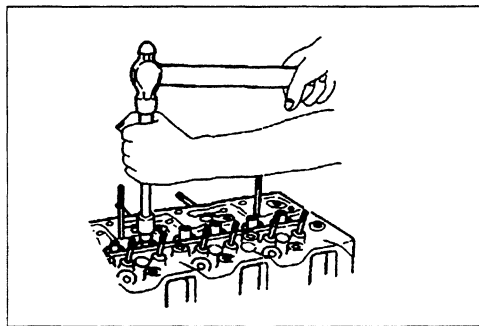


Fig. 116



Intake and Exhaust Valves

- 1) Place the cylinder head on a flat wooden surface.
- 2) Lubricate valve stems with engine oil.
- 3) Install the valves to the intake or exhaust guides.

Install the valves to their original lapped valve seats.

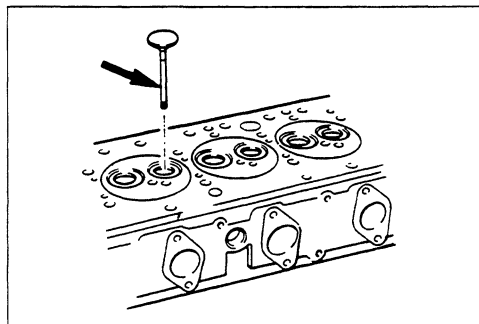


Fig. 117

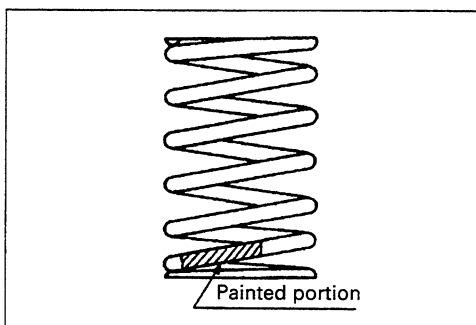


Fig. 118



Intake and Exhaust Valve Springs

Install the valve springs with their painted end (the close pitched end) facing down.

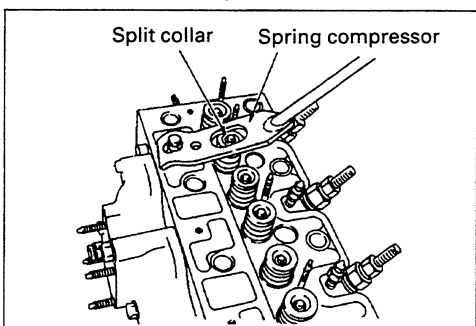


Fig. 119



Spring Seat Split Collar

- 1) Use a spring compressor to push the valve spring into position.
- 2) Install the spring seat split collar.
- 3) Set the spring seat split collar by tapping lightly around the head of the collar with a rubber hammer.

Spring Compressor:

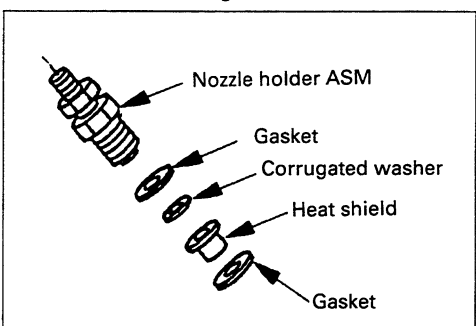


Fig. 120



Nozzle holder assembly

Before assembling the nozzle holder assembly, check to see if the spray condition and the spray pressure of the injection nozzle are appropriate, (Refer to "INSPECTION AND SERVICE.")

Assemble to the cylinder head the gasket (heat shield), heat shield, corrugated washer and gasket (nozzle holder) in this order.

Install the nozzle holder assembly, and then tighten it to the specified torque.



kg·m (ft. lbs.)

| | |
|-------------------|-------------------------|
| Tightening torque | 4.0 – 5.0 (29.0 – 36.0) |
|-------------------|-------------------------|

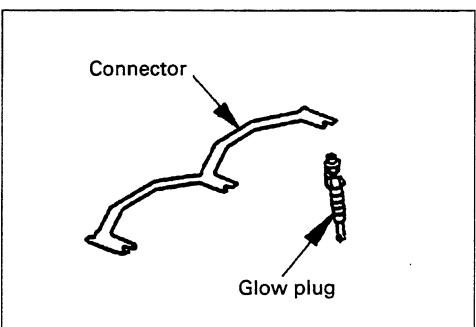


Fig. 121



Glow plug and connector

Assemble the glow plug to the cylinder head, and then tighten it to the specified torque.

Install the connector to the glow plug, and then tighten until snug.

kg·m (ft. lbs.)

| Parts | Tightening torque |
|-----------|-------------------------|
| Glow plug | 1.5 – 2.0 (11.0 – 14.0) |

2. PISTON AND CONNECTING ROD

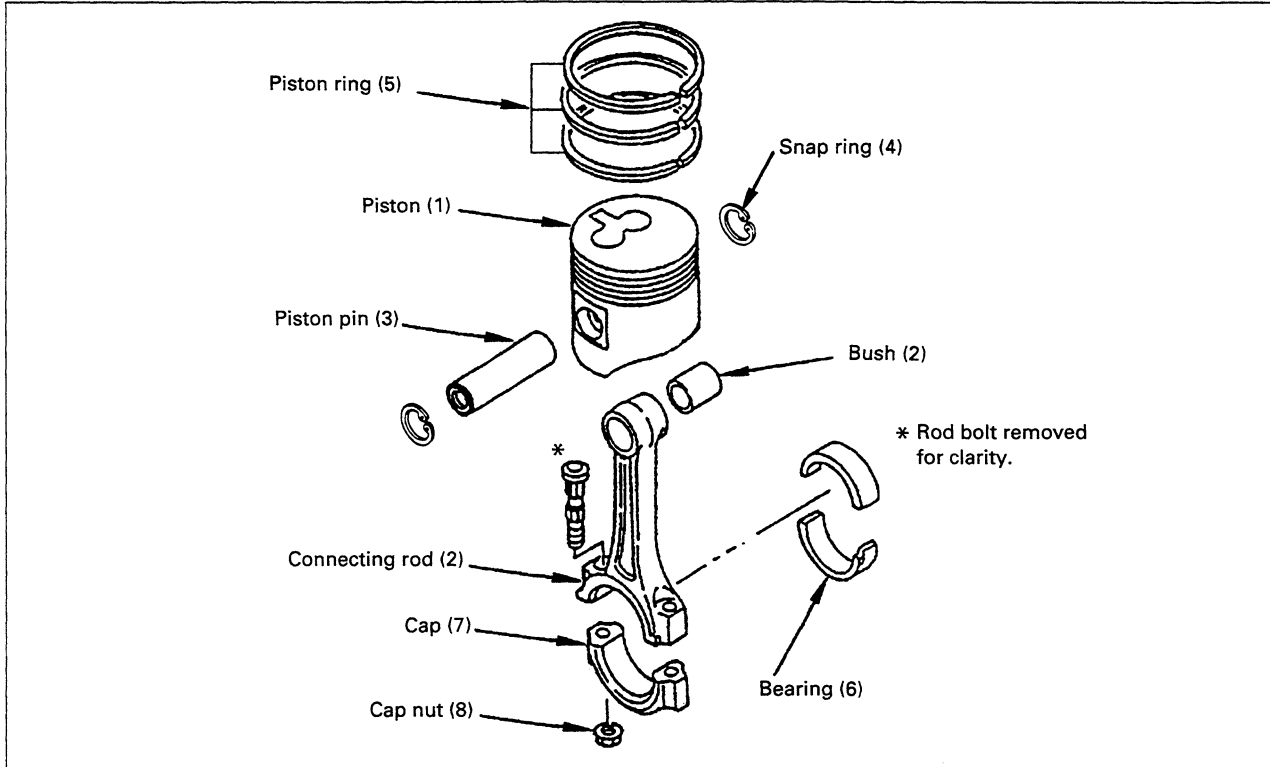


Fig. 122

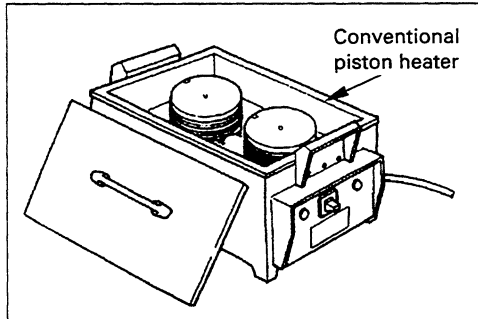


Fig. 123



Important Operations

1. Piston

Use a piston heater to heat the pistons to approximately 100°C (212°F).



2. Connecting Rod

- 1) Install the connecting rod to the piston with setting the marks as illustrated.
- 2) Install the piston pin into the piston and the connecting rod bushing.

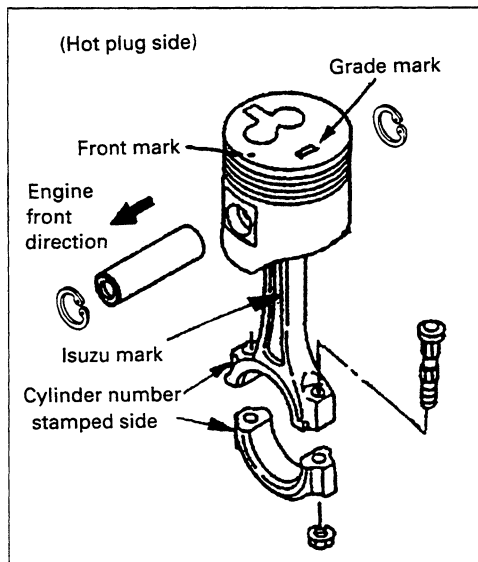


Fig. 124

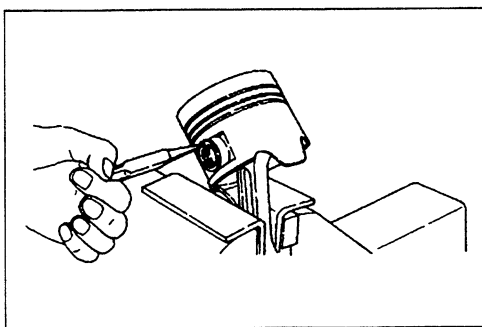


Fig. 125



3. Piston Pin Snap Ring

- 1) Use a pair of snap ring pliers to install the piston pin snap ring.
- 2) Check that the piston moves smoothly on the piston pin.

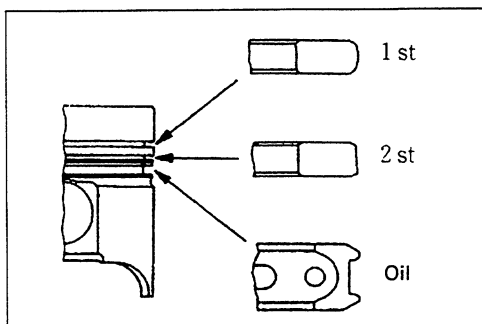


Fig. 126



4) Piston Ring

- 1) Use a piston ring installer to install the three piston rings.

Piston Ring Installer

Install the piston rings in the following order.

- (1) Oil ring
- (2) 2nd compression ring
- (3) 1st compression ring

The marked side of the two compression rings must be facing up.

The undercut side of the second compression ring will be facing down.

As the oil ring has no any facing mark, it may face in either direction.



- 2) Lubricate the piston ring surfaces with engine oil.
- 3) Check that the piston rings rotate smoothly in the piston ring grooves.

3. INTERNAL PARTS



Reassembly Steps

- (1) Crankshaft
- (2) Piston Assembly
- (3) Rear Seal Retainer
- (4) Camshaft
- (5) Cam Gear
- (6) Idler gear and Shaft
- (7) Oil Pump Assembly
- (8) Timing Gear Case (Without PTO)
- (9) Flywheel Housing
- (10) Flywheel
- (11) Crank Pulley
- (12) Oil Pipe
- (13) Oil Strainer
- (14) Oil Pan
- (15) Tappets
- (16) Cylinder Head Gasket
- (17) Cylinder Head Assembly
- (18) Push Rods
- (19) Rocker Bracket Assembly
- (20) Engine Hangers



Internal Parts (1/3)

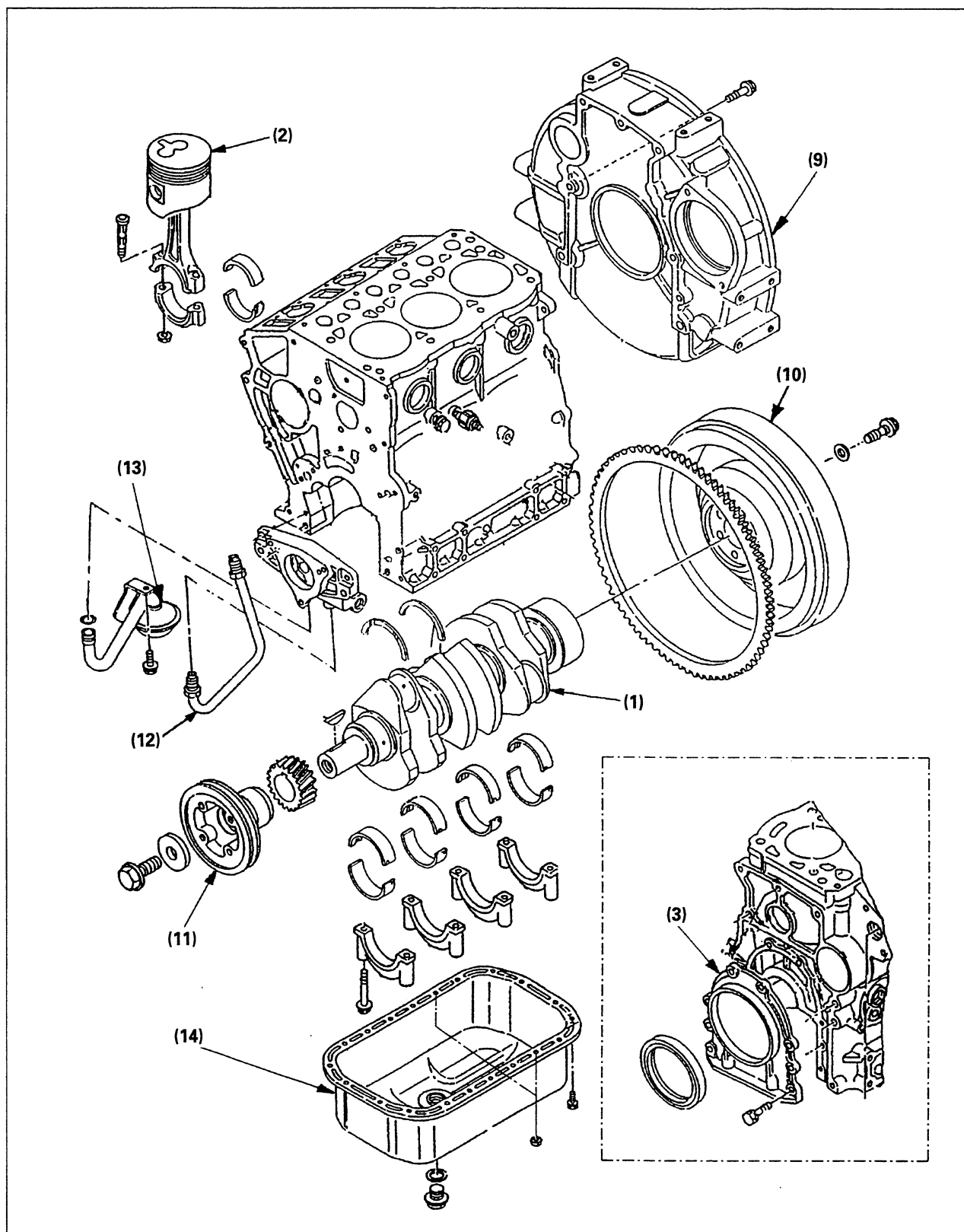


Fig. 127



Internal Parts (2/3)

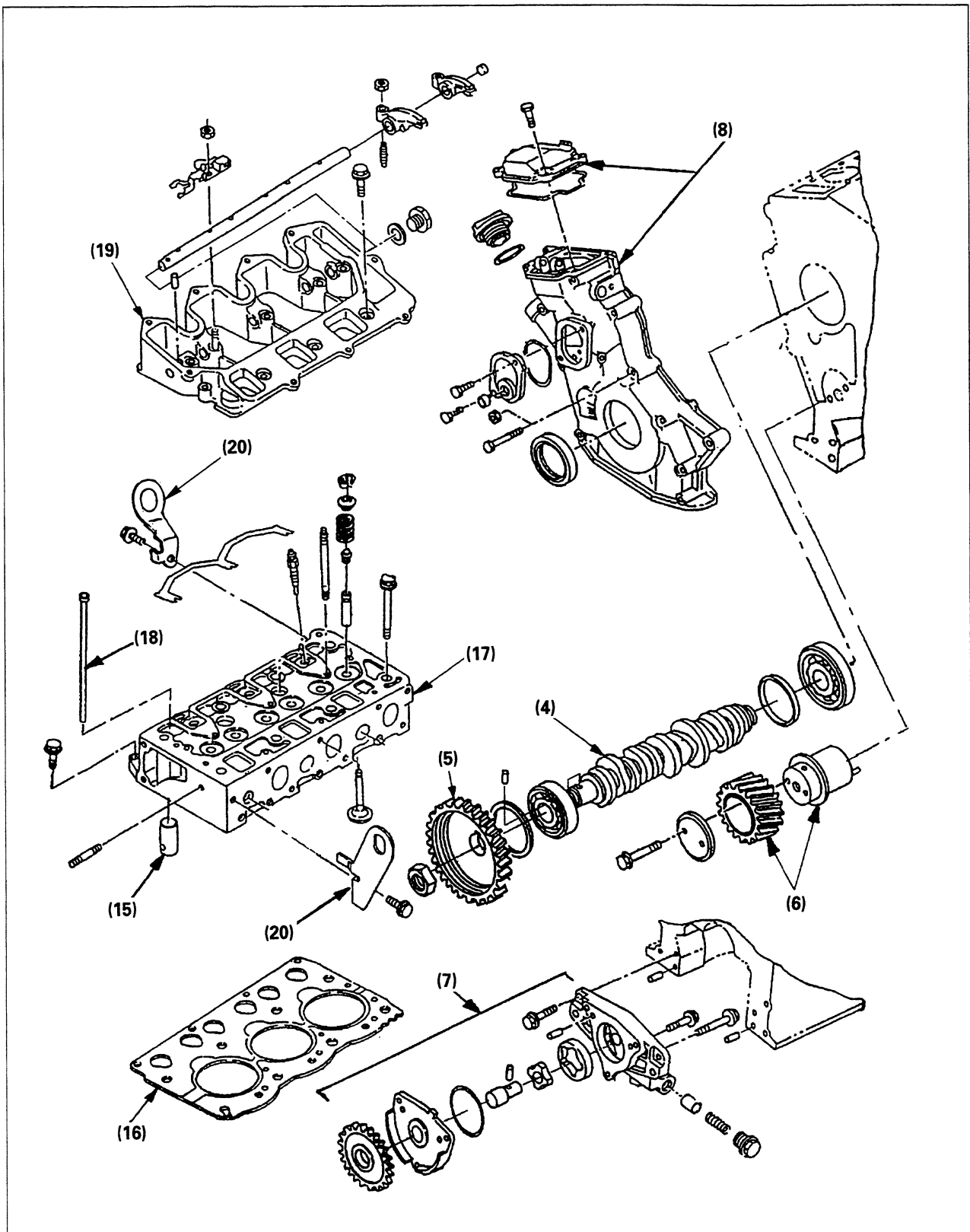


Fig. 128



Internal Parts (3/3)

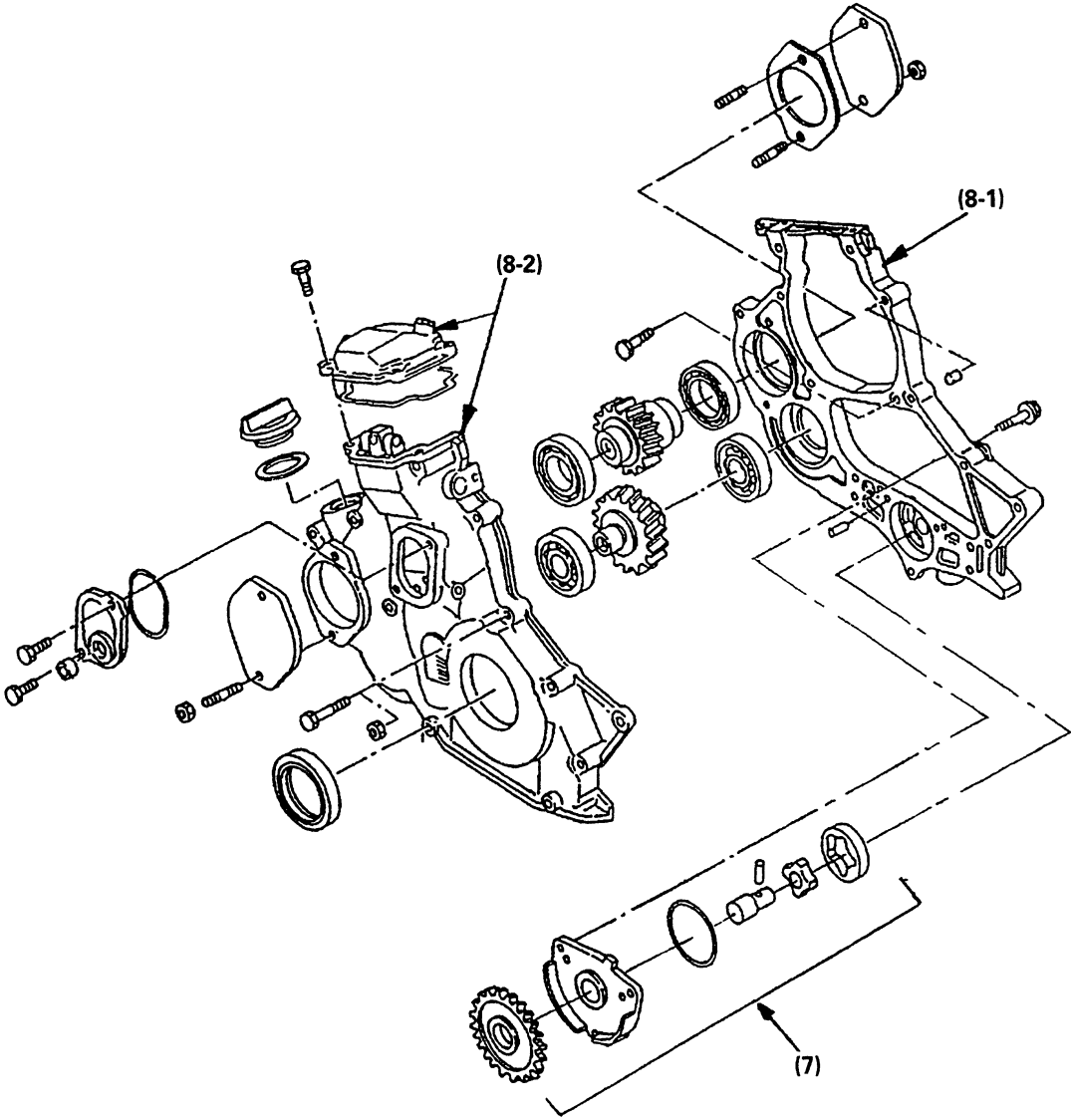


Fig. 129

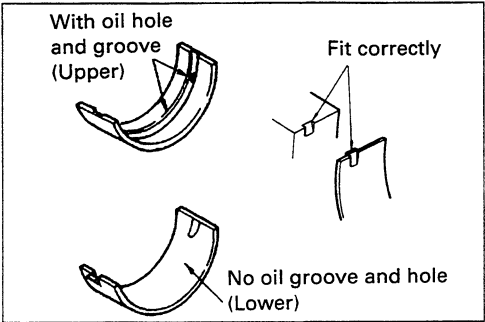


Fig. 130

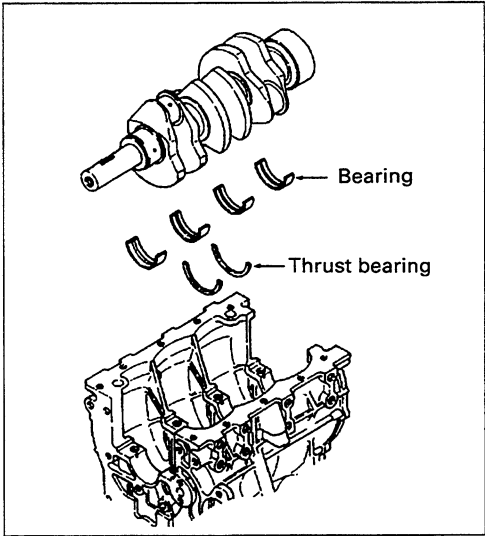


Fig. 131

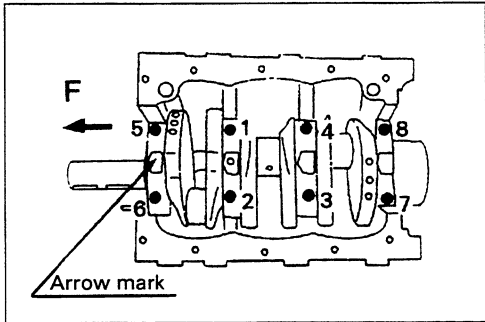


Fig. 132



Crankshaft bearing

Note that there is an oil hole and an oil groove in the upper bearing (on the block side), but not in the lower bearing (on the bearing cap side).

Fit the bearing tang firmly into the slot machined on the cylinder body bearing arches.



Crankshaft and bearing

Lubricate the bearings with engine oil, install the crankshaft, install the thrust bearings with the groove facing the crankshaft.



Crankshaft Bearing Cap

- 1) Lubricate the bearing cap bolts with engine oil.
- 2) Install the bearing caps to the crankshaft.
The arrow mark must be pointing to the front of the engine.
- 3) Tighten the bearing cap bolts to the specified torque a little at a time in the numerical order shown in the illustration.



kg·m (lb.ft)

| | |
|------------------------------------|-------------------------|
| Crankshaft Bearing Cap Bolt Torque | 8.5 – 9.5 (61.0 – 69.0) |
|------------------------------------|-------------------------|

- 4) Check that the crankshaft turns smoothly by manually rotating it.

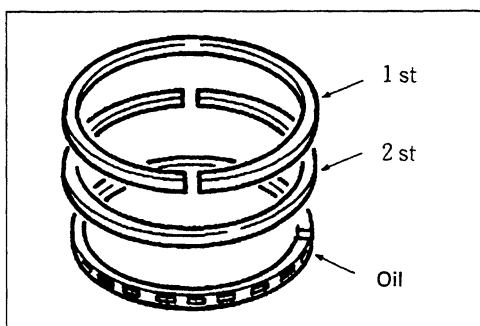


Fig. 133



Position the rings as shown making sure the ring gaps are away from the thrust side.

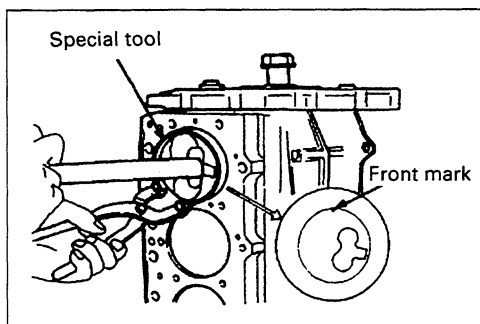


Fig. 134



Piston and Connecting Rod

Lubricate the piston, the piston rings, and the connecting rod bearings with engine oil.



Position the piston front mark towards the front of the engine.



Use the piston ring compressor to compress the piston rings.

Use a hammer grip to push the piston in until it makes contact with the crank pin.

At the same time, rotate the crankshaft until the crankpin reaches its highest point.

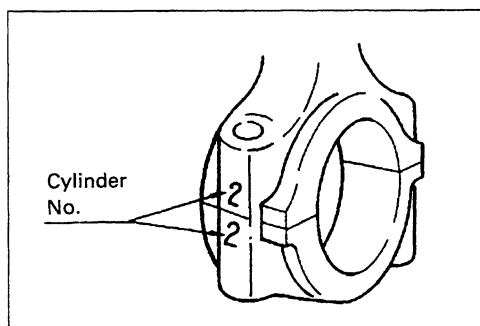


Fig. 135



Set the bearing cap cylinder number marks and the connecting rod cylinder number marks.



The marks must be facing the injection pump side.



kg·m (ft. lbs.)

| | | |
|-------------------|------|------------------------|
| Tightening torque | 3LA1 | 3.8 – 4.2 (27 – 30) |
| | 3LB1 | |
| | 3LD1 | 7.5 – 8.5 (54 – 61) |

Note:

After installation, confirm that the crankshaft rotates smoothly.

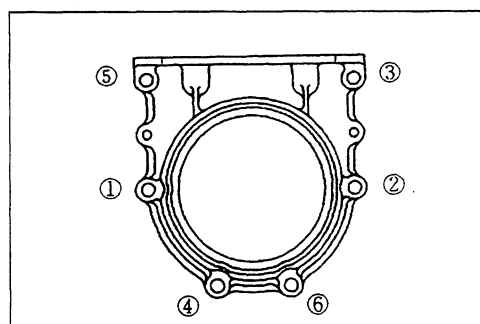


Fig. 136



Installation of retainer

After applying engine oil to the lip of the oil seal, install the retainer. Apply liquid gasket.



Tighten bolts on the retainer to the specified torque in the order as shown in the figure left.



kg·m (ft. lbs.)

| | |
|-------------------|-----------------------|
| Tightening torque | 0.8 – 1.2 (6.0 – 9.0) |
|-------------------|-----------------------|

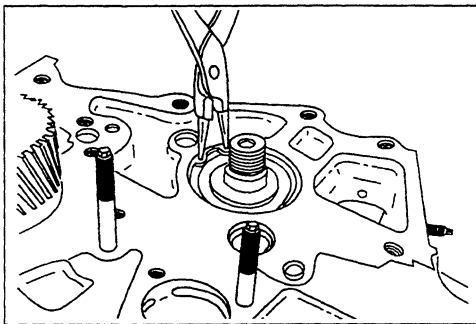


Fig. 137

**Camshaft assembly**

1. Apply engine oil to the inside of the bearing of the cylinder block, and then install the camshaft assembly.

Note:

When installing the assembly, care should be taken not to damage the bearing.

2. After installation of the snap ring to the outside of the front bearing, check to see if the camshaft rotates smoothly.

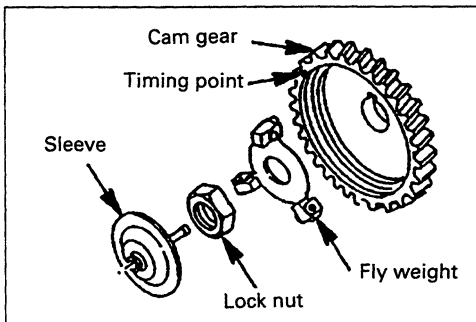


Fig. 138

**Cam gear and sleeve**

1. Install the cam gear to the camshaft so that the timing point (a dot mark "•") comes to the front side.
2. With the flyweight installed, tighten the cam gear with a lock nut.

kg·m (ft. lbs.)

| | |
|-------------------|-------------------------|
| Tightening torque | 7.0 – 9.0 (51.0 – 65.0) |
|-------------------|-------------------------|

3. Apply engine oil to the shaft of the sleeve and the slide of the flyweight.
4. With the lip of the sleeve placed in the cavity of the flyweight, insert the shaft of the sleeve into the tip end of the camshaft.

Note:

Check to see if the sleeve moves smoothly.

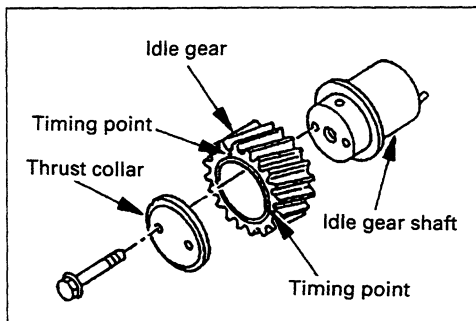


Fig. 139

**Idle Gear**

Install the idler gear shaft with the oil hole facing upward.

Lubricate the shaft with oil.

Install the idler gear.

Align the timing marks as shown in the illustration.

Install the thrust collar and tighten the bolts to the specified torque.

kg·m (ft. lbs.)

| | |
|-------------------|-------------------------|
| Tightening torque | 2.7 – 3.5 (20.0 – 25.0) |
|-------------------|-------------------------|

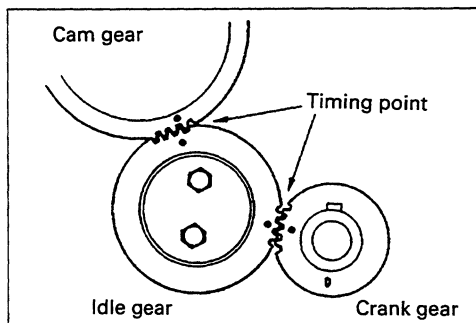


Fig. 140

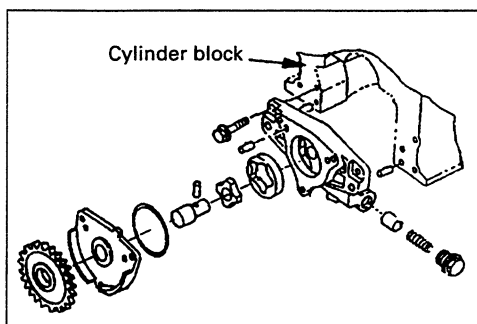


Fig. 141

**Oil pump assembly**

1. When PTO is not provided, install the oil pump assembly to the cylinder block.



PTO not provided

kg·m (ft. lbs.)

| | |
|-------------------|-------------------------|
| Tightening torque | 1.9 – 2.9 (14.0 – 21.0) |
|-------------------|-------------------------|

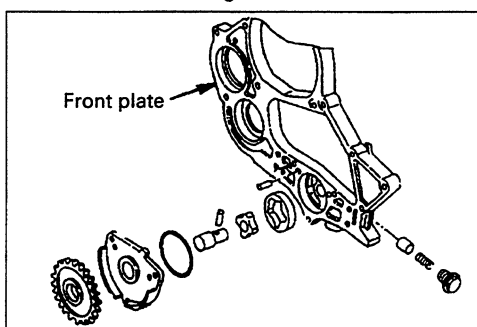


Fig. 142



2. When PTO is provided, install the oil pump to the front plate.



PTO provided

kg·m (ft. lbs.)

| | |
|-------------------|-----------------------|
| Tightening torque | 0.8 – 1.2 (6.0 – 9.0) |
|-------------------|-----------------------|

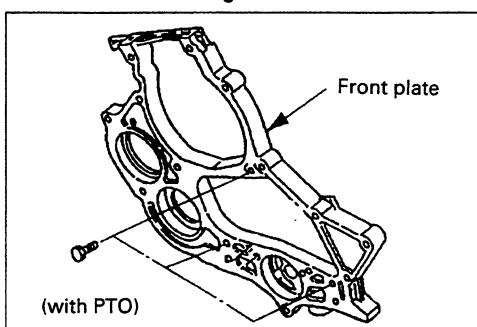


Fig. 143

**Front plate (only for those provided with PTO)**

Apply liquid gasket to the front plate incorporated with the oil pump before installing it to the cylinder block.



kg·m (ft. lbs.)

| | |
|-------------------|-------------------------|
| Tightening torque | 1.9 – 2.9 (14.0 – 21.0) |
|-------------------|-------------------------|

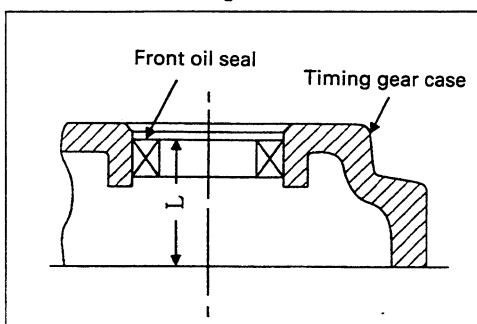


Fig. 144

**Front oil seal**

Install the front oil seal to the timing gear case.



Installation is made according to the "L" dimension shown in the figure.

mm (in.)

| | L dimension |
|------------------|-----------------------------|
| PTO not provided | 60.2 – 60.8 (2.370 – 2.384) |
| PTO provided | 40.2 – 40.8 (1.582 – 1.606) |

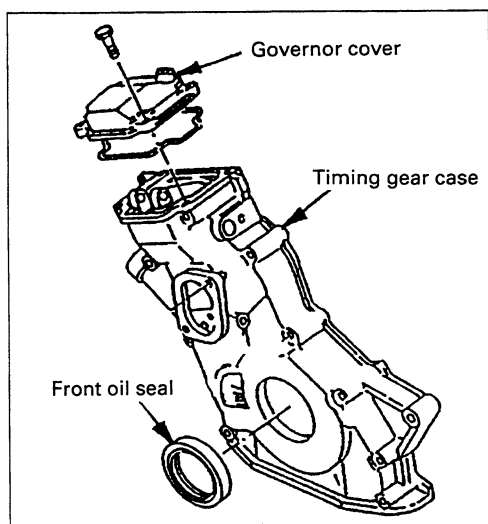


Fig. 145

**Timing gear case (with governor)**

When not provided with PTO, install the timing gear case to the cylinder block. When provided with PTO, install it to the front plate.



1. Put the link plate of the governor incorporated in the gear case through the connecting hole of the injection pump in advance.
2. Apply engine oil to the bushes provided on both ends of the main spring lever of the governor.
3. Apply liquid gasket to the gear case, and then install it to the cylinder block or the front plate.

kg·m (ft. lbs.)

| | |
|------------------------|-------------------------|
| Case tightening torque | 1.9 – 2.9 (14.0 – 21.0) |
|------------------------|-------------------------|



4. Assemble the gasket and the governor cover to the top of the gear case, and then tighten them to the specified torque.

kg·m (ft. lbs.)

| | |
|-------------------------|-----------------------|
| Cover tightening torque | 0.8 – 1.2 (6.0 – 9.0) |
|-------------------------|-----------------------|

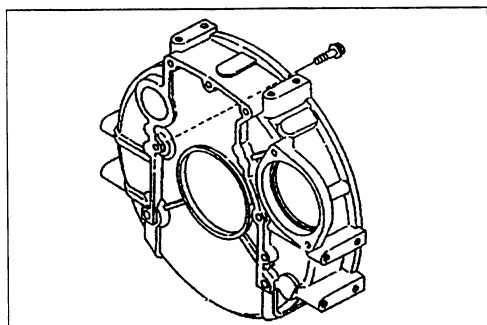


Fig. 146

**Flywheel housing**

Install the flywheel housing to the cylinder body.



kg·m (ft. lbs.)

| | |
|-------------------|-------------------------|
| Tightening torque | 4.2 – 5.6 (30.0 – 40.0) |
|-------------------|-------------------------|

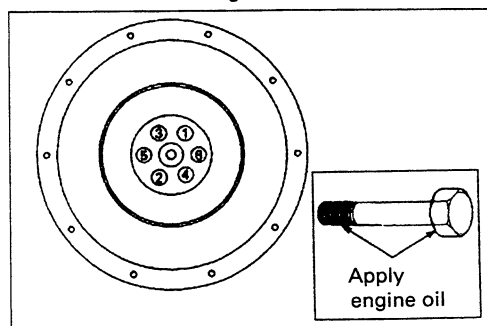


Fig. 147

**Flywheel**

Lubricate bolts with engine oil.



Tighten a little at a time in the sequence shown in the illustration.



kg·m (ft. lbs.)

| | |
|-------------------|--------------------------|
| Tightening torque | 9.0 – 11.0 (65.0 – 80.0) |
|-------------------|--------------------------|



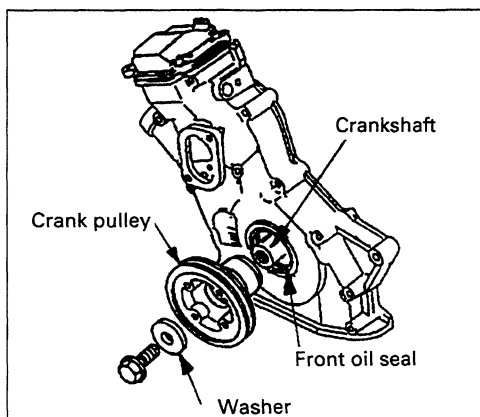


Fig. 148

**Crank pulley**

Lubricate the lip of the front, seal with oil



Install the crank pulley, lock the crankshaft and tighten the front bolt.

kg·m (ft. lbs.)

| | |
|-------------------|-----------------------------|
| Tightening torque | 17.0 – 19.0 (123.0 – 137.0) |
|-------------------|-----------------------------|

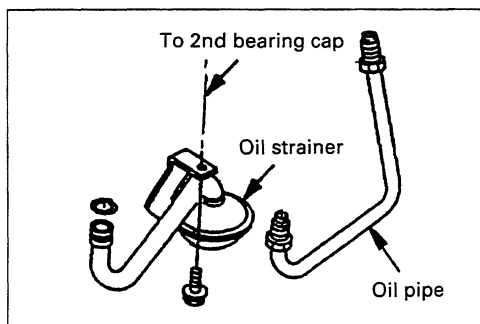


Fig. 149

**Oil pipe and oil strainer**

1. Install the oil pipe from the oil pump assembly to the cylinder block and tighten the sleeve nuts.
2. Install the oil strainer to the oil pump, and then tighten the bracket of the strainer to the No. 2 bearing cap.

kg·m (ft. lbs.)

| | |
|-------------------|-------------------------|
| Tightening torque | 1.9 – 2.9 (14.0 – 21.0) |
|-------------------|-------------------------|

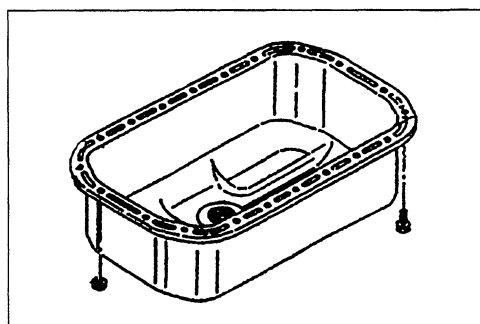


Fig. 150

**Oil pan**

1. Apply liquid gasket to the oil pan.
2. Install the oil pan to the cylinder block and tighten fixing bolts evenly.

kg·m (ft. lbs.)

| | |
|-------------------|-----------------------|
| Tightening torque | 0.8 – 1.2 (6.0 – 9.0) |
|-------------------|-----------------------|

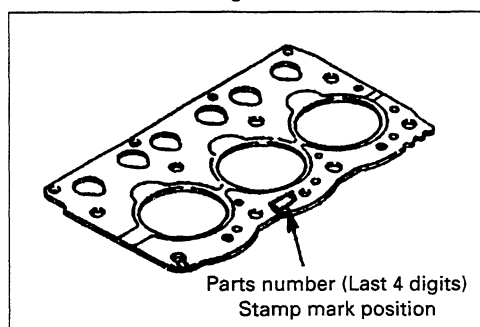


Fig. 151

**Tappet and head gasket**

1. Install the tappet to the cylinder block.
2. When installing the head gasket, turn up the stamp mark of the parts number (last 4 digits) which is between the No. 2 and No. 3 cylinders of the gasket.

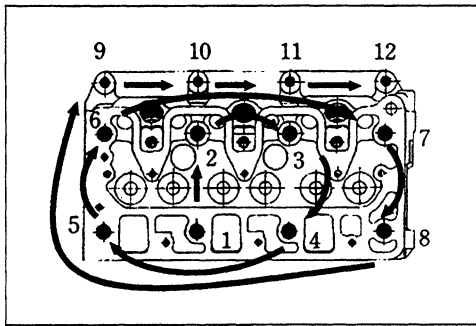


Fig. 152

**Cylinder head assembly**

Lubricate the bolts with oil.



Tighten the bolts in the sequence shown in the illustration to the specified torque.



kg·m (ft. lbs.)

| Bolt size | Tightening torque | |
|-----------------------|------------------------|-------------------------------|
| M12 × 1.5 (8 each) | 8.5 – 9.5 (61 – 69) | → 60° ^{+30°} – 0° |
| M8 × 1.25 (4 each) | 2.5 – 3.5 (18 – 25) | — |

**Push rod**

Install the push rods.

**Rocker arm bracket assembly**

Apply liquid gasket to the the bottom of the rocker arm bracket assembly, being careful not to get any in the groove around the oil galley as shown in the illustration.



Install the rocker arm bracket assembly making sure the push rods align with the rocker arms and tighten to the specified torque.

kg·m (ft. lbs.)

| Tightening torque | 0.8 – 1.2 (6.0 – 9.0) |
|-------------------|-----------------------|
|-------------------|-----------------------|

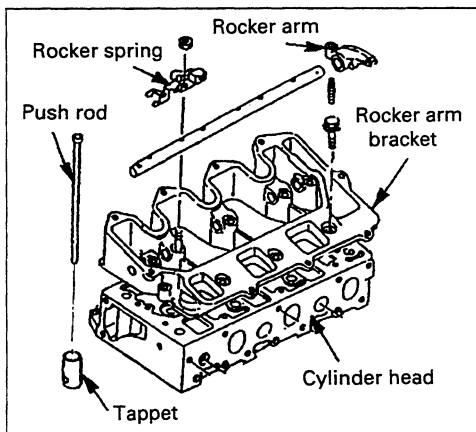


Fig. 153

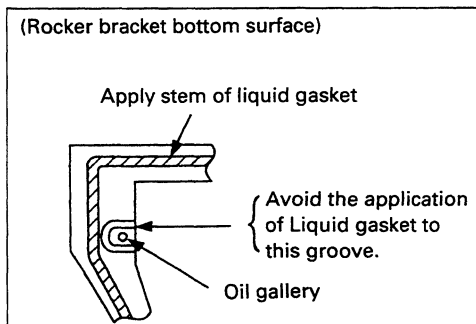


Fig. 154

Refer to Section "General Information – Maintenance" (on page 20).



Adjustment of valve clearance

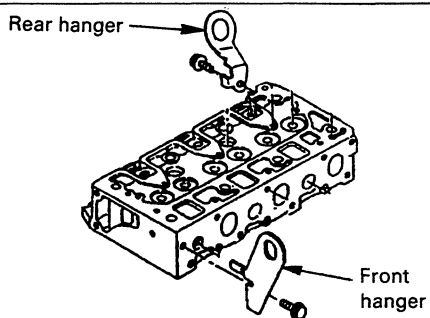


Fig. 155



Front hanger and rear hanger

Tighten them to the specified torque shown below.

kg·m (ft. lbs.)



Tightening torque

1.9 – 2.9 (14.0 – 21.0)

4. EXTERNAL PARTS (Right-hand Side)

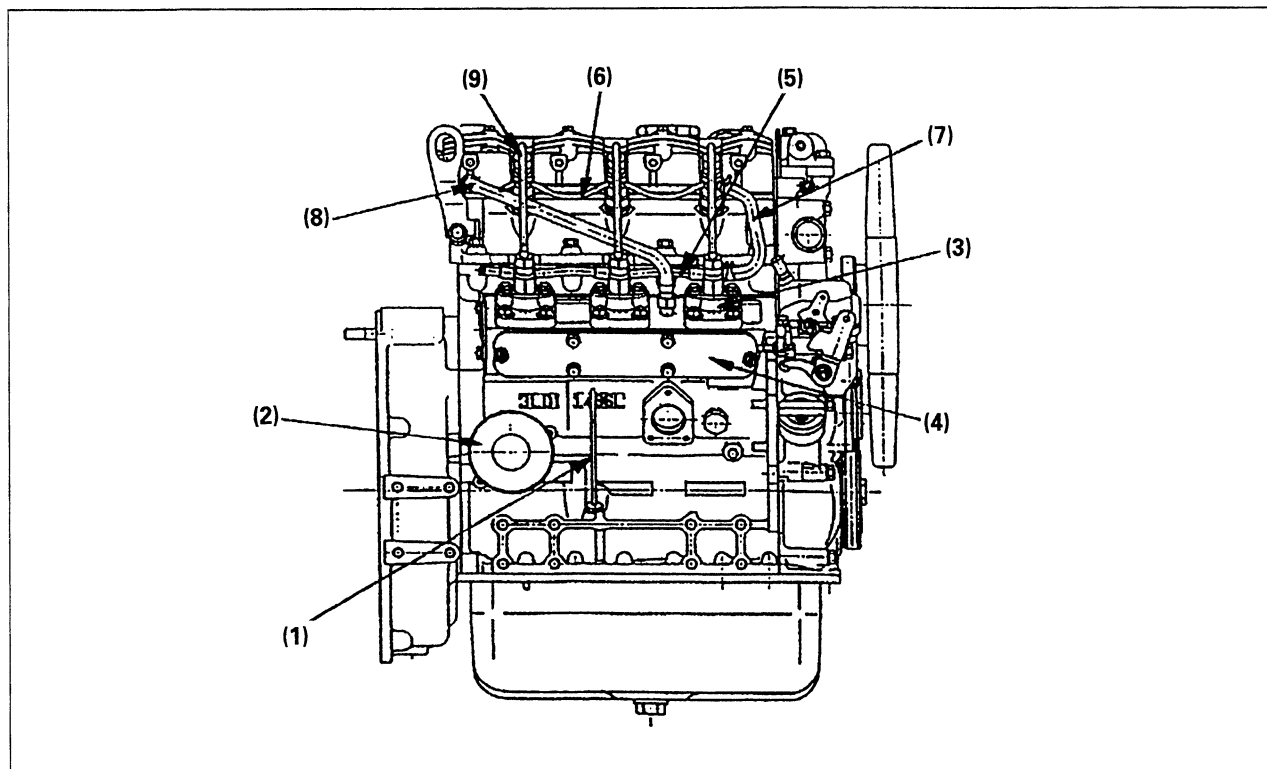
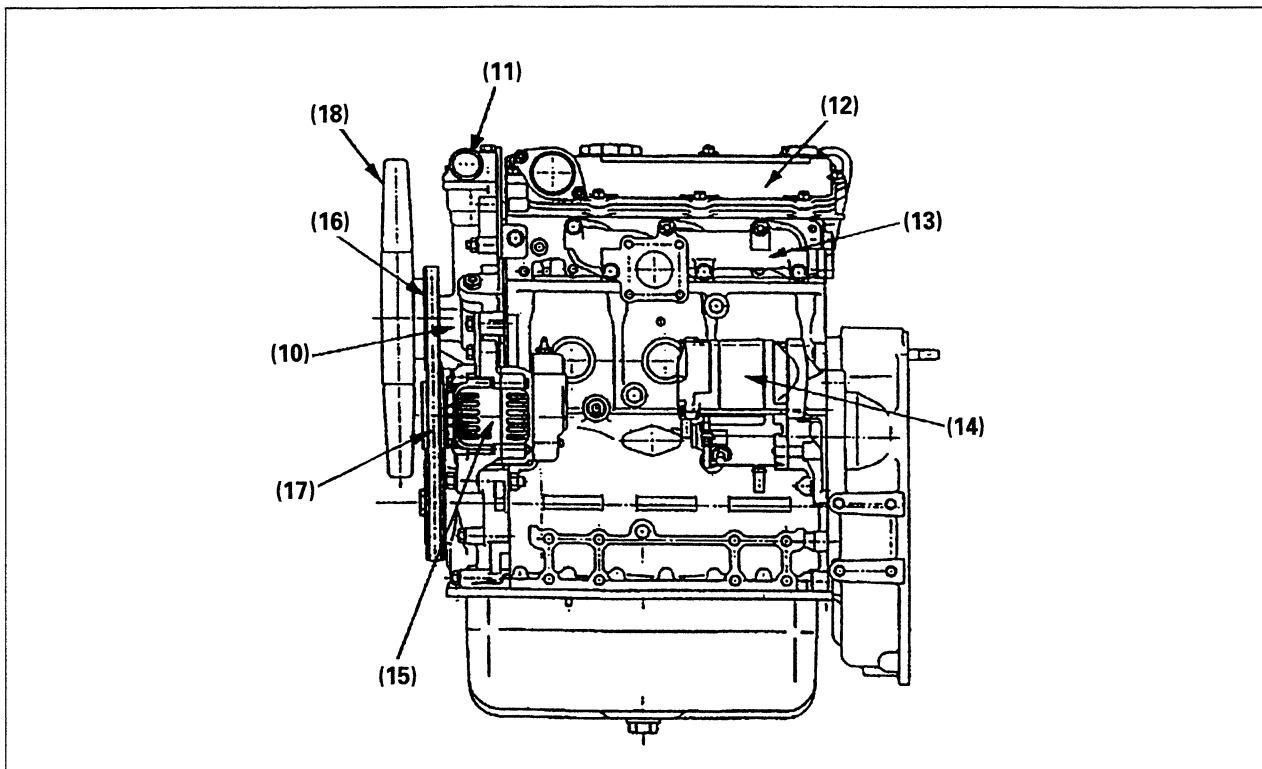


Fig. 156



- (1) Dipstick
- (2) Oil Filter
- (3) Injection Pump
- (4) Injection Pump Housing Cover
- (5) Fuel Pipe
- (6) Leak Off Pipe
- (7) Fuel Hose
- (8) Blowby Hose
- (9) Injection Pipe

5. EXTERNAL PARTS (Left-hand Side)**Fig. 157**

- (10) Water Pump**
- (11) Thermostat and Water Outlet Pipe**
- (12) Cylinder Head Cover**
- (13) Exhaust Manifold**
- (14) Starter**
- (15) Generator**
- (16) Fan Pulley**
- (17) Fan Belt**
- (18) Cooling Fan**

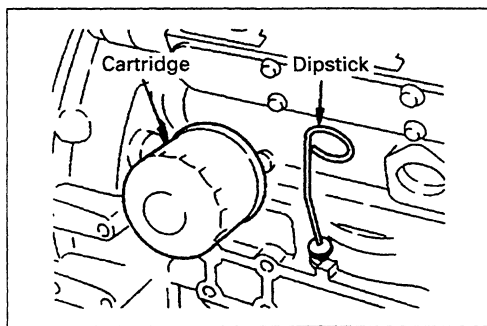


Fig. 158

**Dipstick****Oil filter (cartridge)**

1. Insert the dipstick.
 2. Install the cartridge with a filter wrench (commercially available).
- (1) Apply engine oil thinly to the gasket of the cartridge.
 - (2) Screw in the cartridge until the gasket comes into contact with the seal, and then tighten it by giving it about 3/4 turns.

(Reference: Tightening torque 1.2 to 1.6 kg·m
(8.6 – 11.6 ft. lbs.))

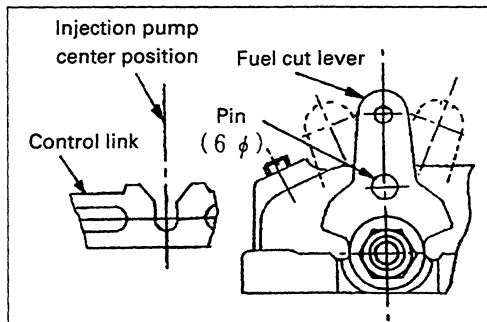


Fig. 159

**Injection pump**

Align the two (2) holes in the fuel cut lever and the governor and lock into place with a pin.

This will center and hold the control link for the installation of the injection pumps.

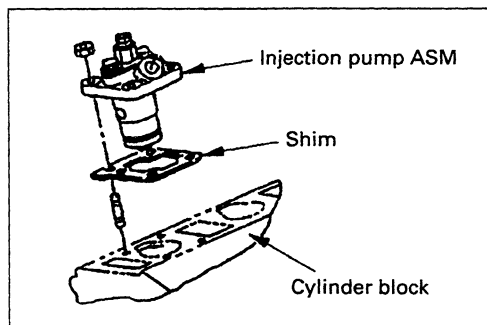


Fig. 160



Install a new shim with the same thickness as the one that was removed. (Refer to the maintenance section on shim selection).

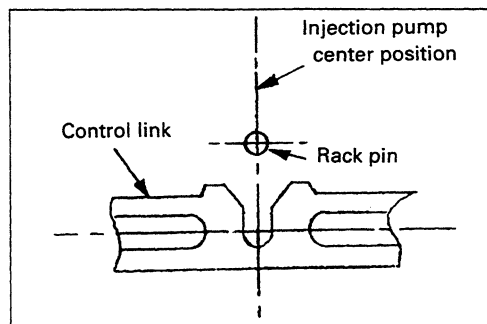


Fig. 161



Install the injection pump making sure the rack pin is in the groove of the control rack before tightening the injection pump to the specified torque.



kg·m (ft. lbs.)

| | |
|-------------------|-------------------------|
| Tightening torque | 1.9 – 2.9 (14.0 – 21.0) |
|-------------------|-------------------------|

Remove the rack pin (6φ) which is inserted into the fuel cut lever, and then confirm that the fuel cut lever moves smoothly.

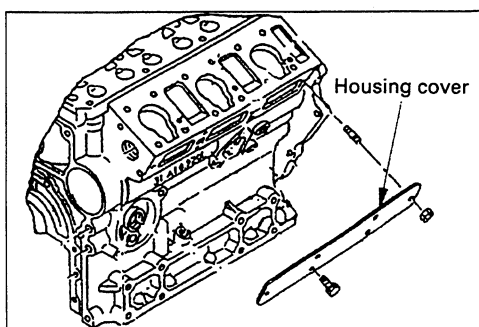


Fig. 162

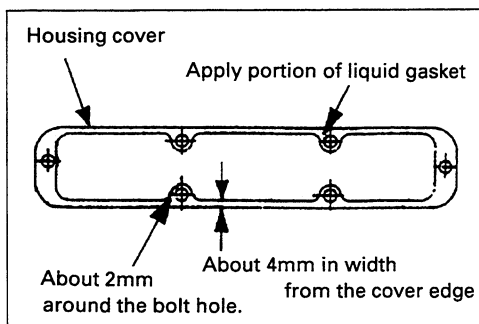


Fig. 163

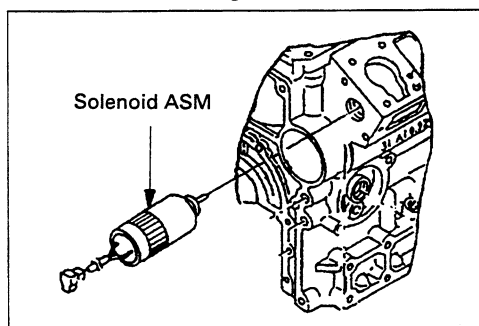


Fig. 164

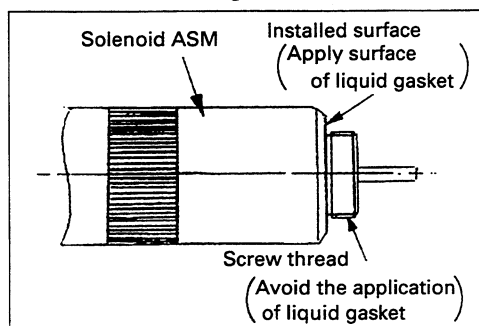


Fig. 165

**Injection pump housing cover**

After applying liquid gasket (TB1207C) to the housing cover, install it to the cylinder block by the side of the injection pump.

kg·m (ft. lbs.)

| | |
|-------------------|-----------------------|
| Tightening torque | 0.8 – 1.2 (6.0 – 9.0) |
|-------------------|-----------------------|

Note:

The areas of the housing cover to which liquid gasket is applied are about 4 mm in width from the cover edge and about 2 mm around the bolts.

**Solenoid assembly**

1. Apply liquid gasket (TB1207C) to the surface (bite groove) in which the solenoid is installed.

Note:

Avoid the application of liquid gasket to the screw thread.

2. Screw in the solenoid from the rear of the cylinder block (the rear of the No. 3 injection pump rack), and then tighten it to the specified torque.

kg·m (ft. lbs.)

| | |
|-------------------|-------------------------|
| Tightening torque | 1.5 – 2.5 (11.0 – 18.0) |
|-------------------|-------------------------|

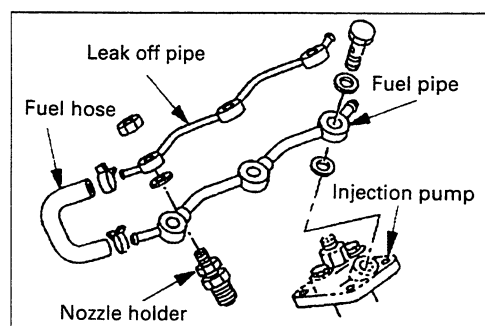


Fig. 166

**Fuel pipe****Leak off pipe**

1. Install the fuel pipe to the injection pump and then tighten it to the specified torque.
2. Install the leak off pipe to the nozzle holder and then tighten it to the specified torque.

kg·m (ft. lbs.)

| Tightening torque | |
|-------------------|-------------------------|
| Fuel pipe | 2.0 – 2.5 (14.0 – 18.0) |
| Leak off pipe | 2.5 – 3.5 (18.0 – 25.0) |

Note:

When tightening it, hold the pipe securely by hand so that it will not rotate.

3. Connect the fuel pipe and the leak off pipe with the fuel hose and fix them with clips.

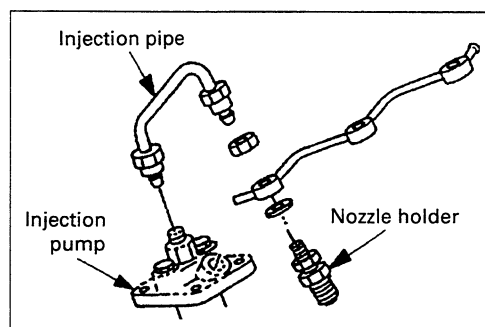


Fig. 167

**Injection pipe**

Install the injection pipe to the injection pump and the nozzle holder and tighten them up with sleeve nuts.

kg·m (ft. lbs.)

| | |
|-------------------|-------------------------|
| Tightening torque | 1.5 – 2.5 (11.0 – 18.0) |
|-------------------|-------------------------|

Note:

Set the thread of the sleeve nut securely before tightening it up.

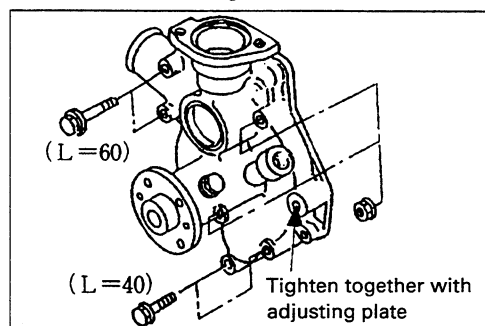


Fig. 168

**Water pump assembly**

1. Put liquid gasket on the water pump where it contacts the block and head.
2. Tighten to the specified torque.

kg·m (ft. lbs.)

| | |
|-------------------|-------------------------|
| Tightening torque | 1.9 – 2.9 (14.0 – 21.0) |
|-------------------|-------------------------|

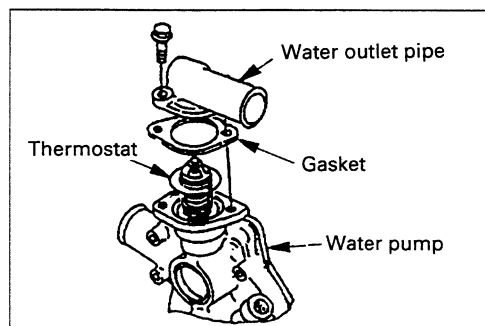


Fig. 169

**Thermostat****Water outlet pipe**

Assemble the thermostat, install the gasket and the water outlet pipe, and then tighten it to the specified torque.

kg·m (ft. lbs.)

| | |
|-------------------|-------------------------|
| Tightening torque | 1.9 – 2.9 (14.0 – 21.0) |
|-------------------|-------------------------|

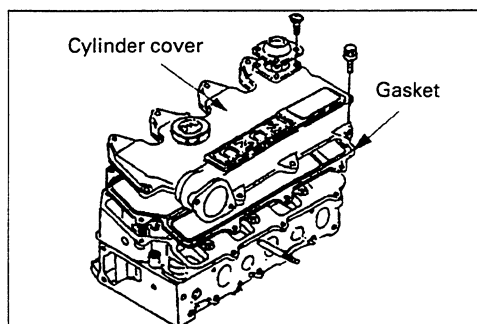


Fig. 170

**Adjustment of valve clearance**

(Refer to Section "GENERAL INFORMATION – MAINTENANCE.")

**Cylinder head cover**

1. Install the gasket to the cylinder head cover.

Notes:

1. **Much care should be taken for the gasket not to get dislocated or twisted when installing the head cover.**
2. **Avoid the application of liquid gasket to the rubber gasket.**
2. Install the cylinder head cover to the rocker arm bracket, and tighten it to the specified torque.

kg·m (ft. lbs.)

| | |
|-------------------|-----------------------|
| Tightening torque | 0.2 – 0.5 (1.4 – 3.6) |
|-------------------|-----------------------|

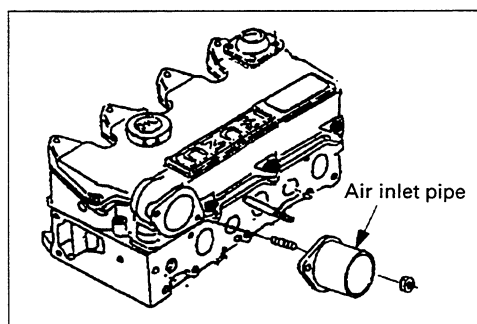


Fig. 171

**Air inlet pipe**

1. Apply liquid gasket (TB1207C) to the surface in which the air inlet pipe is installed.
2. Install the air inlet pipe to the cylinder head cover, and tighten it to the specified torque.

kg·m (ft. lbs.)

| | |
|-------------------|-----------------------|
| Tightening torque | 0.8 – 1.2 (6.0 – 9.0) |
|-------------------|-----------------------|

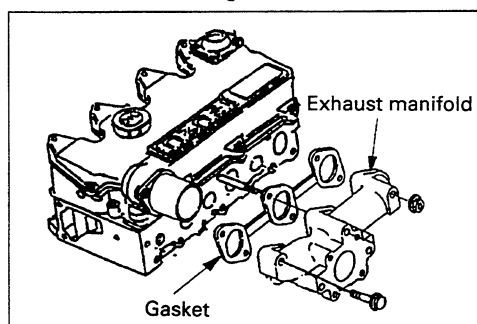


Fig. 172

**Exhaust manifold**

Assemble the gasket to the cylinder head, install the exhaust manifold along the stud bolts and tighten it to the specified torque.

kg·m (ft. lbs.)

| | |
|-------------------|-------------------------|
| Tightening torque | 1.9 – 2.9 (14.0 – 21.0) |
|-------------------|-------------------------|

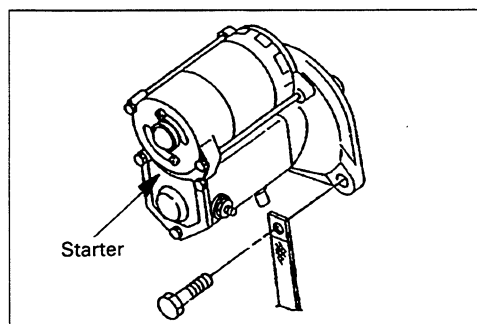


Fig. 173

**Starter**

Install the starter to the flywheel housing, and tighten it to the specified torque.

kg·m (ft. lbs.)

| | |
|-------------------|--------------------------|
| Tightening torque | 8.7 – 10.5 (63.0 – 76.0) |
|-------------------|--------------------------|

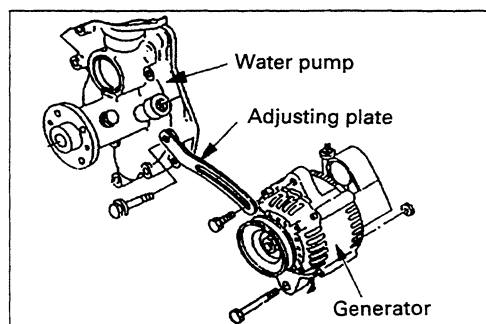


Fig. 174

**Generator**

1. Tighten the adjust plate together with the water pump, and then install them temporarily.
2. Install the bottom of the generator to the timing gear case, and then tighten it temporarily with bolts and nuts.
3. Install the fixing bolts onto the top of the generator through the adjusting plate. (Temporary tightening)

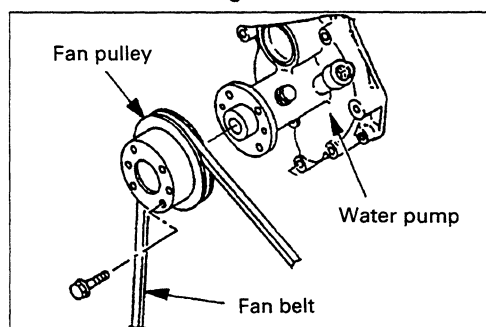


Fig. 175

**Fan pulley and fan belt**

1. Install the fan pulley to the water pump and then tighten it up. (2 locations)

kg·m (ft. lbs.)

| | |
|-------------------|-----------------------|
| Tightening torque | 0.8 – 1.2 (6.0 – 9.0) |
|-------------------|-----------------------|

2. Set the fan belt to each pulley.

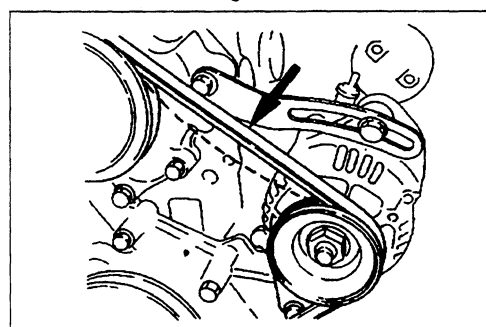


Fig. 176

**Fan belt tension**

Adjust the alternator as specified and tighten to the specified torque.

mm (in.)

| | |
|-------------------------------------------------------------------------------------------------|-----------------------------|
| Deflection amount (Press the belt at its center between the pulleys with 10kg (22 lbs.) force.) | 8 to 10 (0.315 – 0.3937) |
|-------------------------------------------------------------------------------------------------|-----------------------------|

mm (in.)



| | |
|-----------------|-------------------------|
| Generator upper | 1.9 – 2.9 (14.0 – 21.0) |
| Generator lower | 3.5 – 4.7 (25.0 – 34.0) |
| Adjust plate | 1.9 – 2.9 (14.0 – 21.0) |

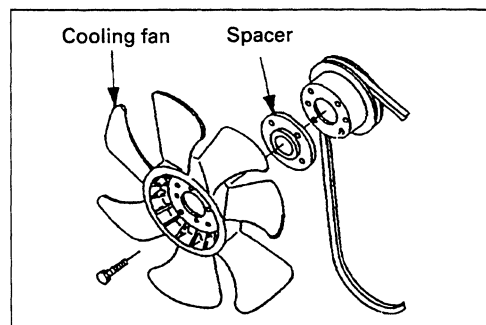


Fig. 177

**Cooling fan**

1. Assemble the spacer before tightening the cooling fan.
2. Tighten it to the specified torque. (4 locations)

kg·m (ft. lbs.)

| | |
|-------------------|-------------------------|
| Tightening torque | 1.9 – 2.9 (14.0 – 21.0) |
|-------------------|-------------------------|



SECTION 3

LUBRICATING SYSTEM

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LUBRICATING OIL CIRCULATION DIAGRAM

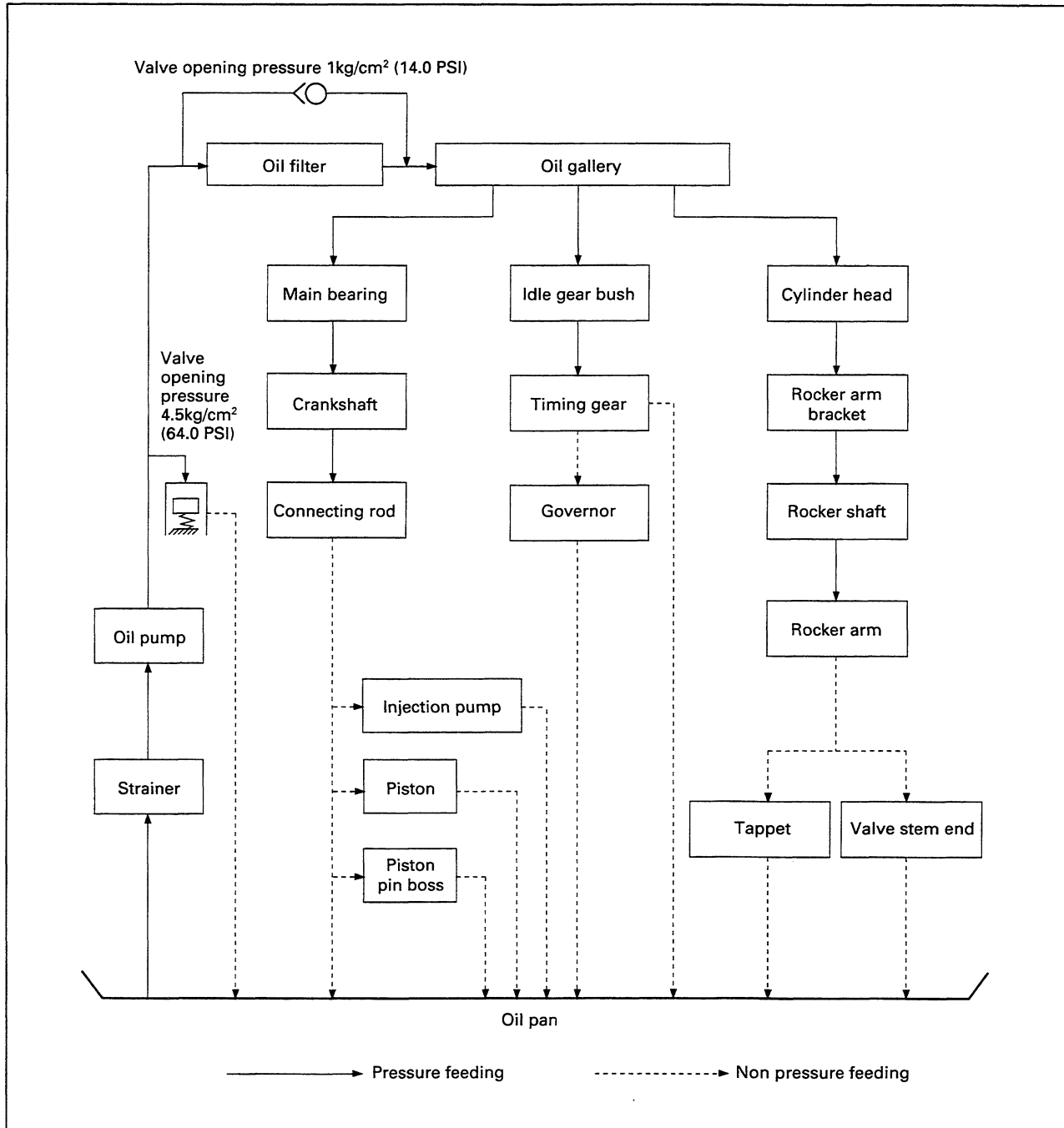


Fig. 178

OIL PUMP

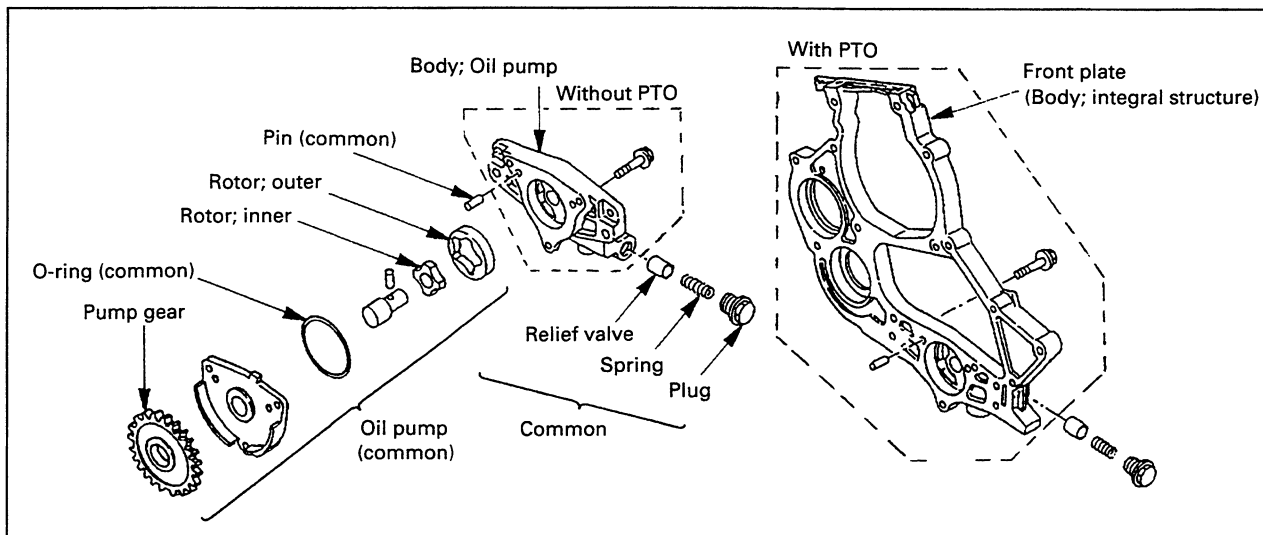


Fig. 179



Inspection and replacement

When there is wear, damages or any other defects found, repair or replace the rotor.



Clearance between the outer rotor or inner rotor and the pump cover

mm (in.)

| Standard | Limit |
|---------------------------------|---------------|
| 0.040 – 0.085 (0.0016 – 0.0033) | 0.15 (0.0059) |



Clearance between the periphery of the outer rotor and the pump body

mm (in.)

| Standard | Limit |
|--------------------------------|--------------|
| 0.10 – 0.185 (0.0039 – 0.0073) | 0.4 (0.0157) |



Clearance between the inner rotor and the outer rotor

mm (in.)

| Standard | Limit |
|---------------|--------------|
| 0.17 (0.0067) | 0.2 (0.0079) |

MEMO

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SECTION 4

COOLING SYSTEM

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COOLING WATER CIRCULATION SYSTEM DIAGRAM

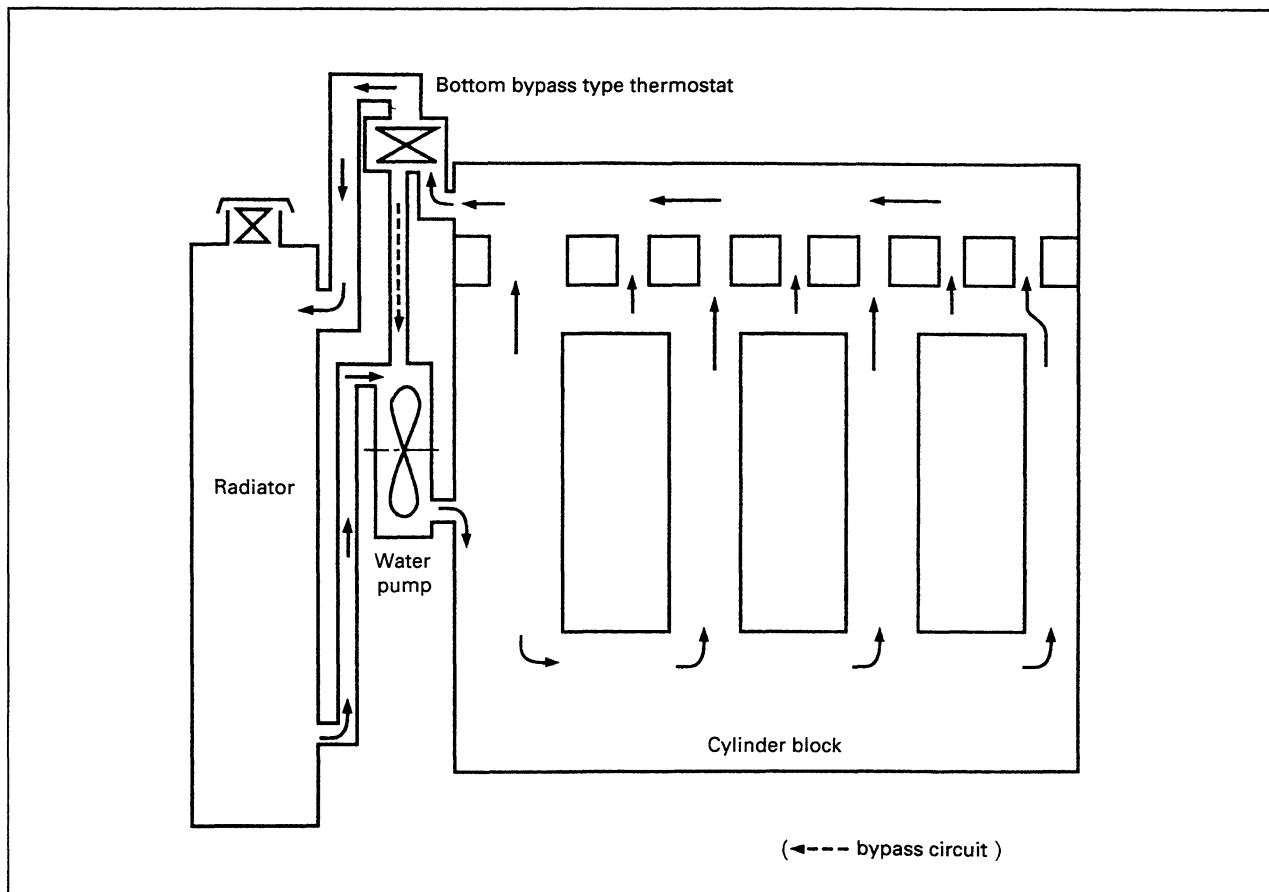


Fig. 180

WATER PUMP



DISASSEMBLY

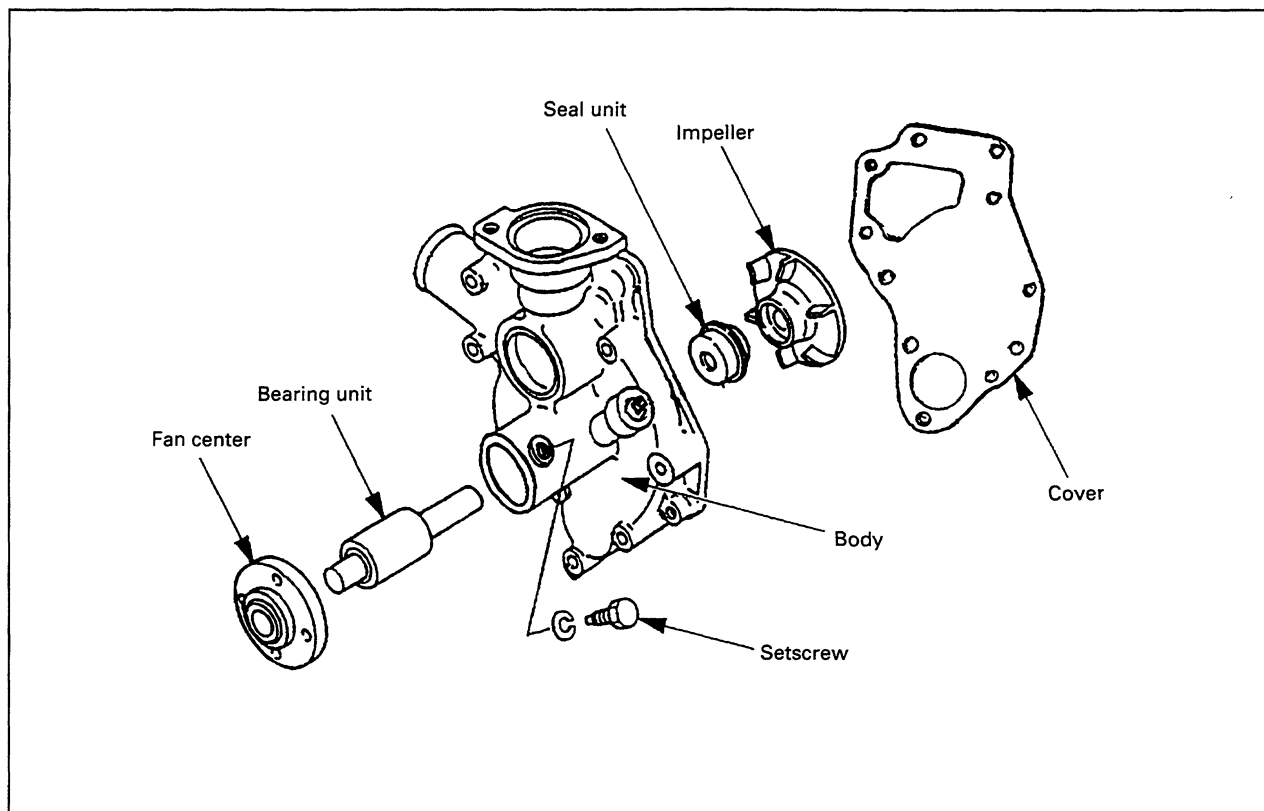


Fig. 181

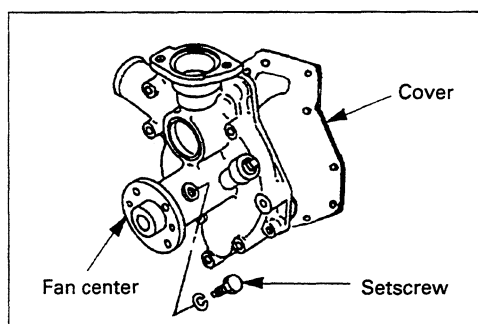


Fig. 182



Fan center

Cover



1. Loosen the set screw.
2. Remove the cover.

Note:

The cover is applied with liquid gasket (TB1207B). When removing the cover, much care should be taken not to deform it by applying an excessive force to it.

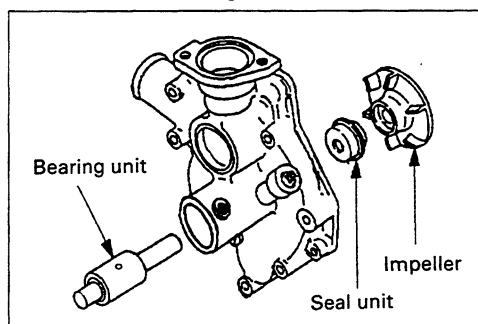


Fig. 183



Impeller

Seal unit

Bearing unit



REASSEMBLY

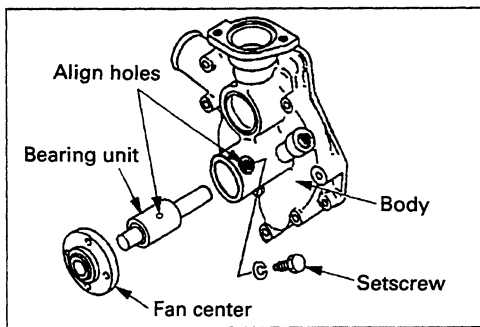


Fig. 184



Bearing unit

With a hole in the bearing unit set in line with one in the body, lock the bearing unit with a setscrew.

kg·m (ft. lbs.)



| | |
|-----------------------------|-----------------------|
| Set screw tightening torque | 0.8 – 1.2 (6.0 – 9.0) |
|-----------------------------|-----------------------|

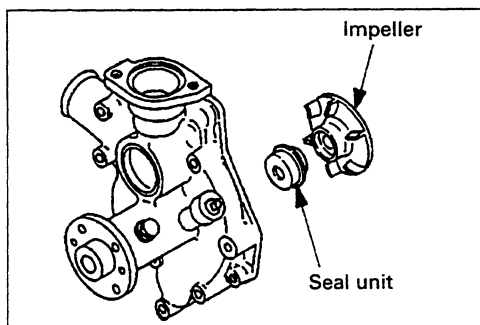


Fig. 185



Seal unit

Impeller

1. Apply BELCO bond No. 4 to the surface where the seal unit comes into contact with the body, and then assemble the seal unit.
2. Press in the impeller with a press until the clearance between the pump impeller and the body gets to the specified value.

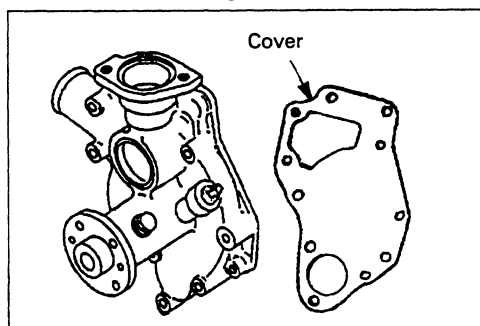


Fig. 186



Cover

1. Apply liquid gasket to the surface to which the cover is installed, and then install the cover.
2. Apply Screw-lock to the cover installation screws, and then tighten them.



Clearance, play and tightening allowance between parts

- (1) Clearance between the pump impeller and the body
mm (in.)

| | |
|----------|-------------------------------|
| Standard | 0.53 – 2.17 (0.0209 – 0.0854) |
|----------|-------------------------------|

- (2) Play in the water pump ball bearing
mm (in.)

| Standard | Limit |
|---------------------------------|--------------|
| 0.008 – 0.010 (0.0003 – 0.0004) | 0.2 (0.0079) |

- (3) Tightening allowance between the fan center and the bearing shaft
mm (in.)

| | |
|----------|--------------------------------|
| Standard | 0.026 – 0.061 (0.001 – 0.0024) |
|----------|--------------------------------|

THERMOSTAT



Inspection and replacement

Replace the thermostat when there is wear, damages or any other defects found.



| | |
|---------------------|------------------------------------------------------|
| Opening temp. | 74.5 – 78.5°C (166 – 174°F) |
| Valve lift mm (in.) | 8mm or more at 90°C (0.315 inch or more at 194°F) |

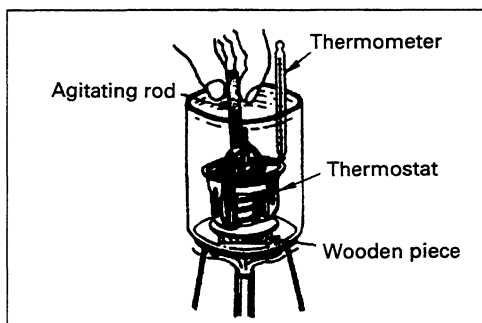


Fig. 187

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SECTION 5

FUEL SYSTEM

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FUEL CIRCULATION SYSTEM DIAGRAM

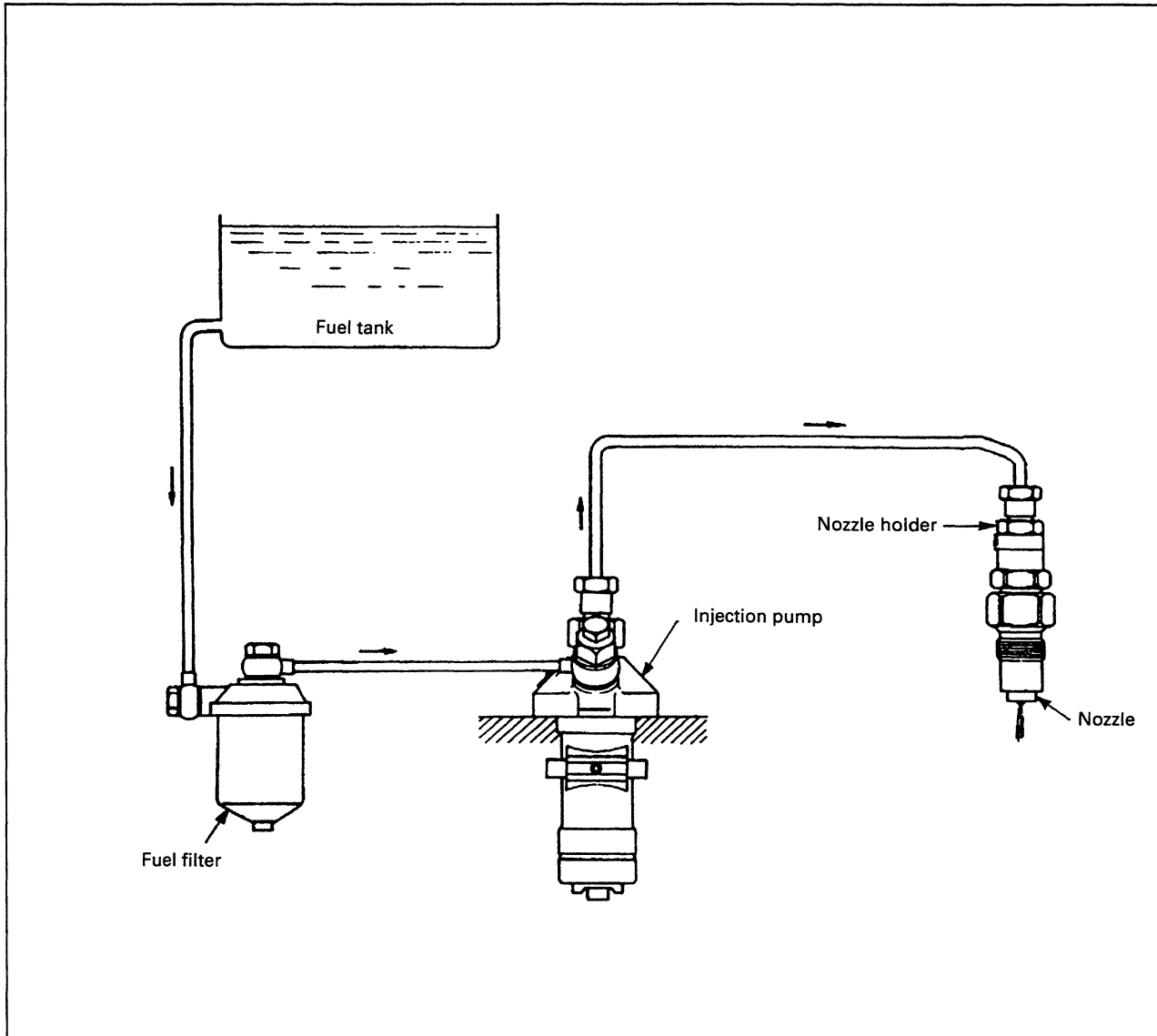


Fig. 188

GOVERNOR

1. The adjustments of the governor-related parts require the engine performance test.
2. Before disassembling the governor, measure the dimensions "A" and "B" given in the structural drawing to ensure the same dimensions in reassembly.
3. Do not disassemble the governor when the performance test cannot be conducted after reassembly.

1. STRUCTURAL DRAWING OF GOVERNOR (1)

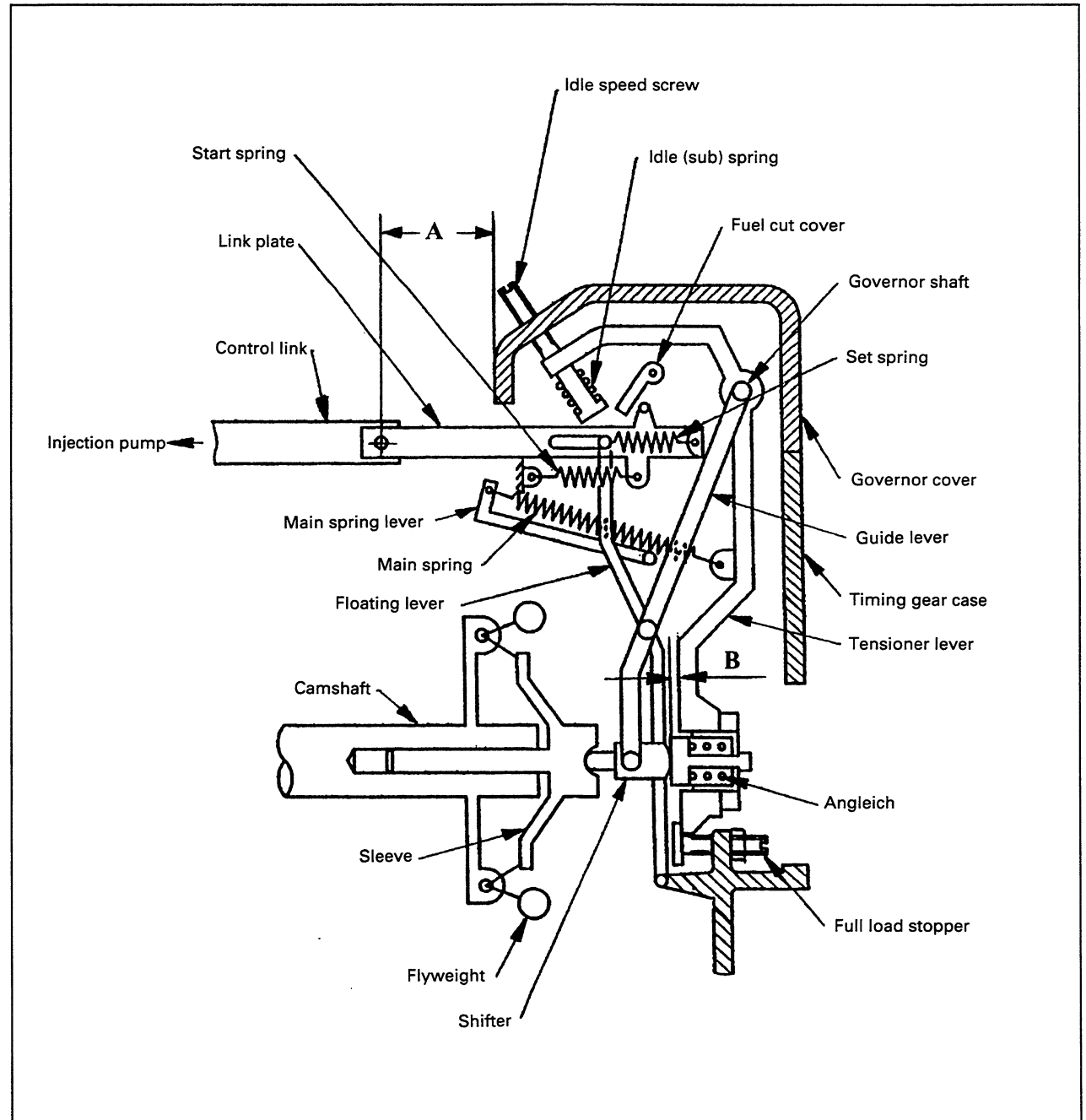


Fig. 189

2. STRUCTURAL DRAWING OF GOVERNOR (2)

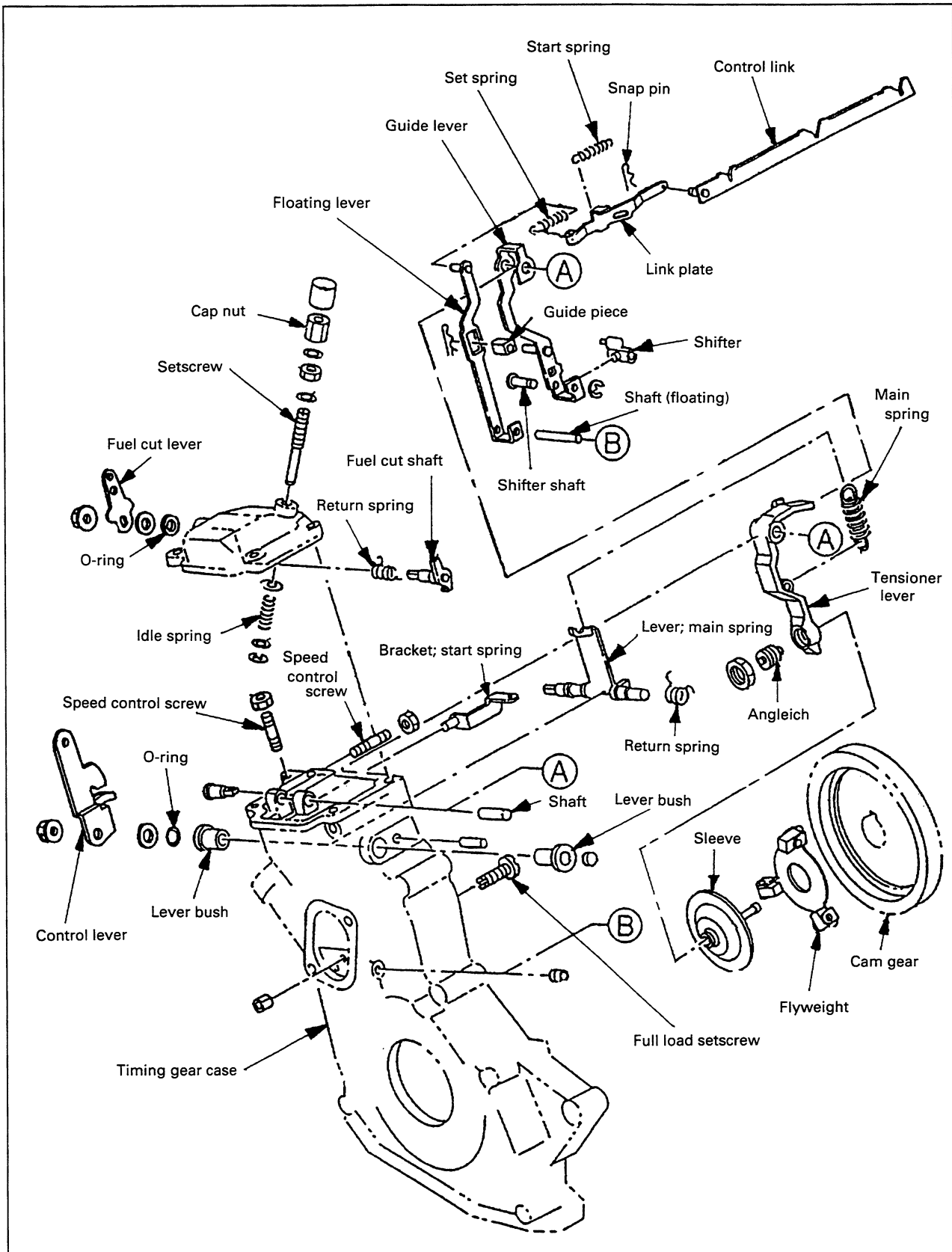


Fig. 190

3. REASSEMBLY OF CONTROL LEVER RELATED PARTS

- (1) Put the lever (main spring) through the hole of the timing gear case lever.

Note:

Before hammering in the bushes, put both shafts of the lever through the holes of the timing gear case lever respectively.

- (2) Put the return spring of the control lever through the shaft of the lever (main spring).

- (3) Assemble the bushes.

Assemble the bush of the lever (main spring) first, and then the control lever bush.

Note:

When assembling the bushes, apply Loctite (#601) to the periphery of the bushes.

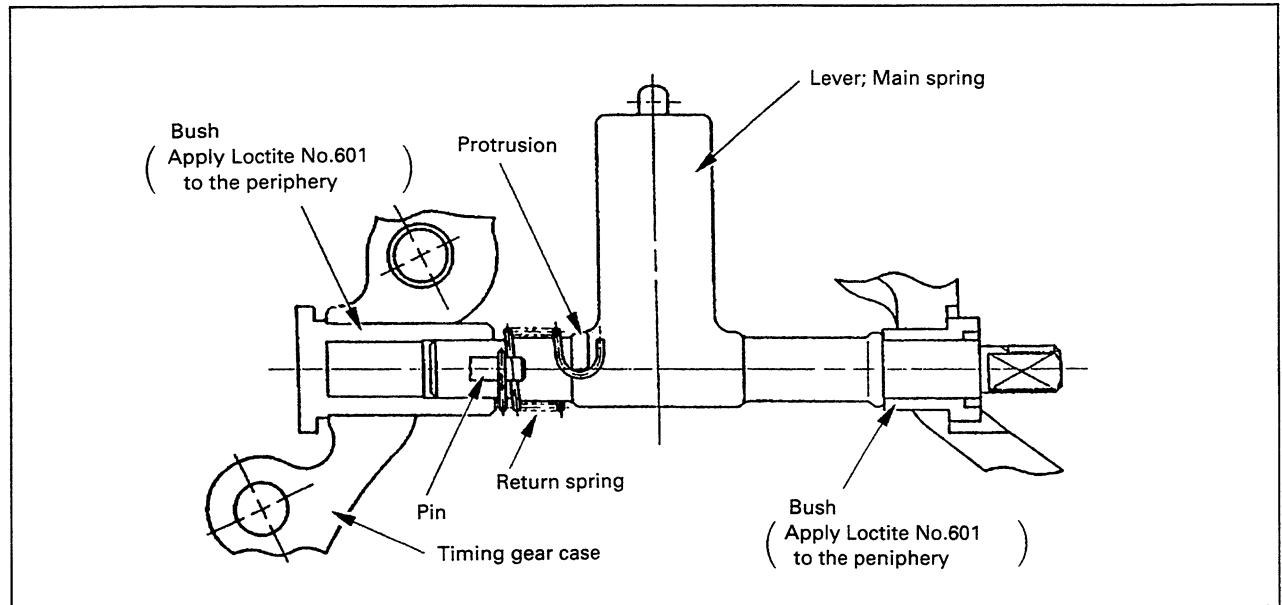


Fig. 191

- (4) Hook both ends of the return spring (control lever) securely to the protrusion and the pin of the lever (main spring) respectively.

(6) Assemble the control lever.

Assemble the O-ring to the groove of the bushes (control lever) first, and then assemble the washers and the control lever before tightening up the control lever with a nut.

kg·m (ft. lbs.)

| | |
|---------------------------------|------------------------|
| Control lever tightening torque | 1.2 – 1.8 (9.0 – 13.0) |
|---------------------------------|------------------------|

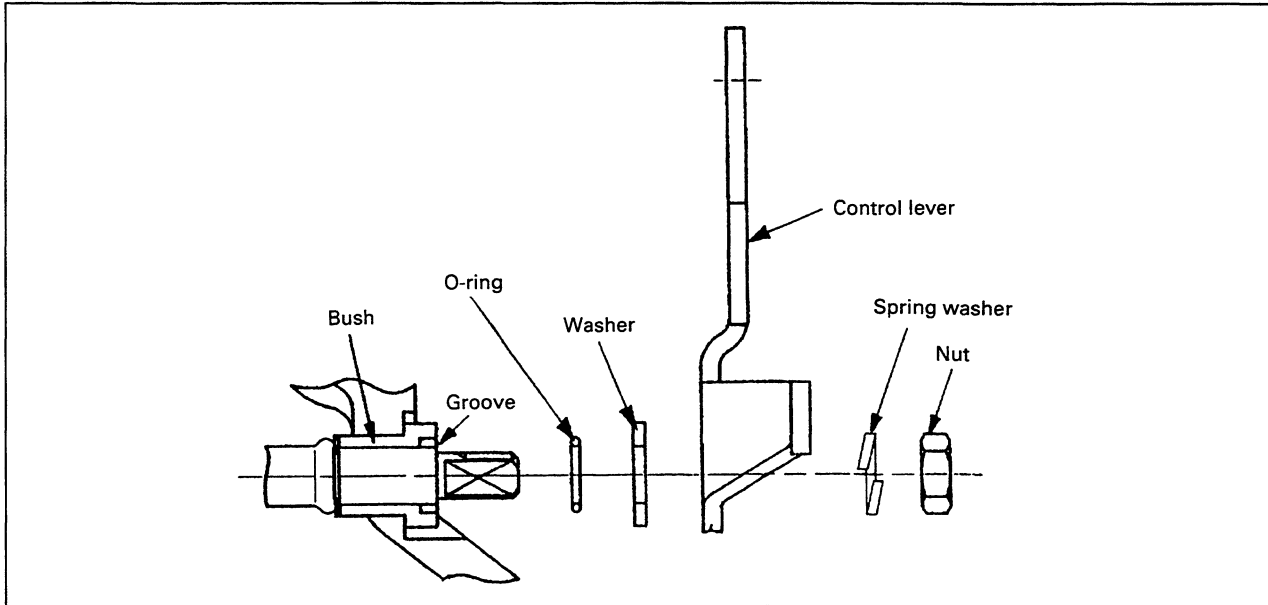


Fig. 192

Notes:

1. Tighten the control lever after locking the control lever firmly.
(Do not tighten the control lever after locking the main spring lever.)
2. After assembly, confirm that the control lever moves smoothly.

4. Reassembly of shifter

- (1) Assemble the shifter to the guide lever, put the shaft through it, and then assemble the snap ring.
- (2) After assembly, confirm that the shaft moves smoothly.
- (3) Also, confirm that the shifter shakes smoothly.

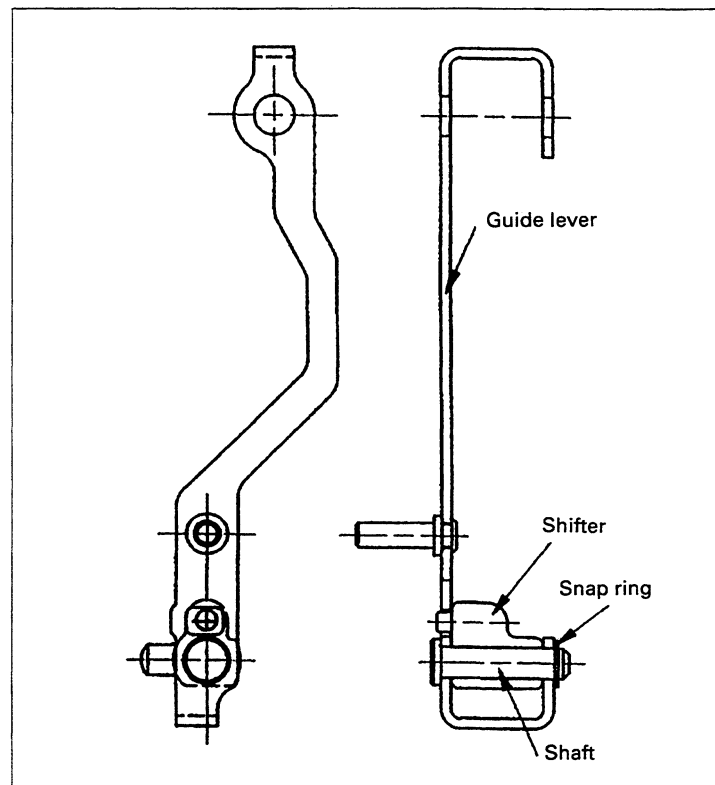


Fig. 193

5. Reassembly of governor cover

Assemble the related parts such as the fuel cut lever and the idle spring to the governor cover.

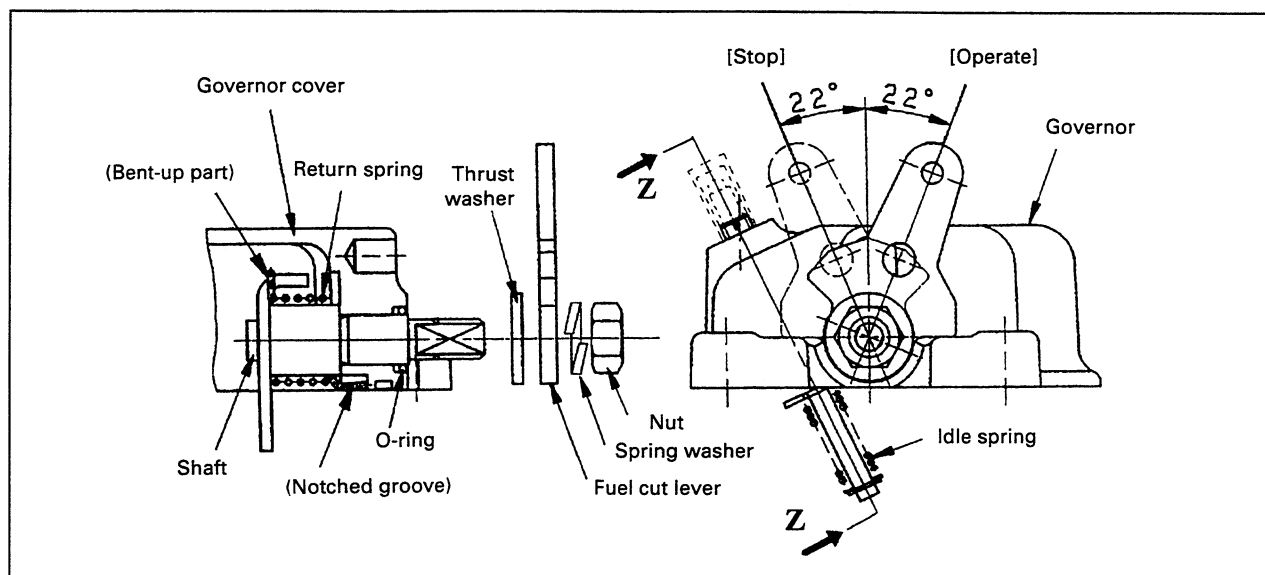


Fig. 194

- (1) When assembling the shaft, apply engine oil to the sliding portion with the governor cover.
- (2) Set both ends of the return spring securely to the notched groove at the bottom of the cover and the bent-up arm of the lever respectively.
- (3) After reassembling the governor cover, confirm that the governor moves smoothly.
- (4) When assembling the timing gear case to the governor cover, tighten the "A" dimension shown in the illustration to 2 – 3 mm temporarily.

The parts given in the square indicated by (*) are assembled after performance test.

mm (in.)

| | |
|---------------|----------------------------------------------------------|
| "A" dimension | (When assembling temporarily) 2 – 3 (0.0787 – 0.0118) |
|---------------|----------------------------------------------------------|

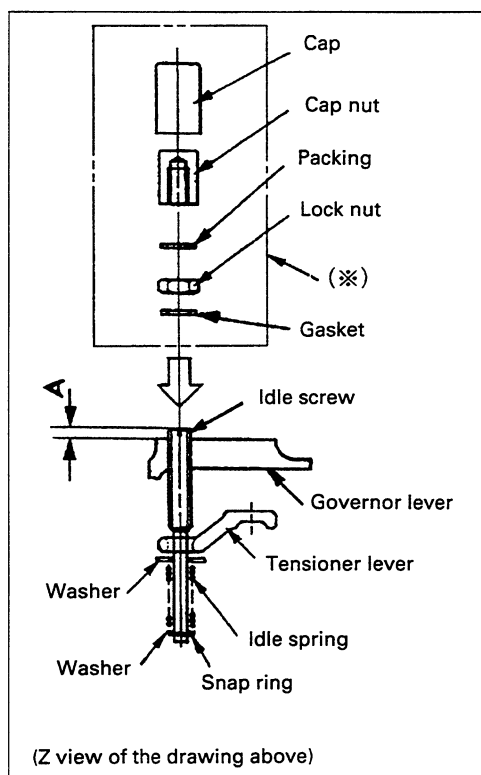


Fig. 195

6. Reassembly of full-load stopper

Install the full-load stopper to the timing gear case, and then tighten it with a nut temporarily.

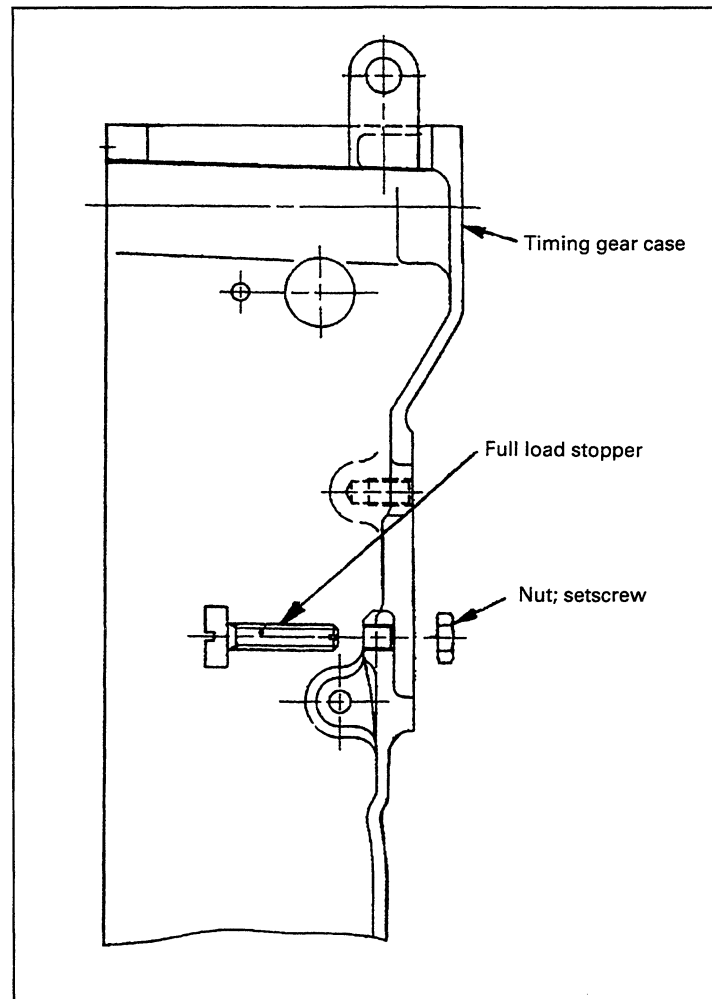


Fig. 196

7. Reassembly of governor lever related components

Assemble each lever and spring to the timing gear case.

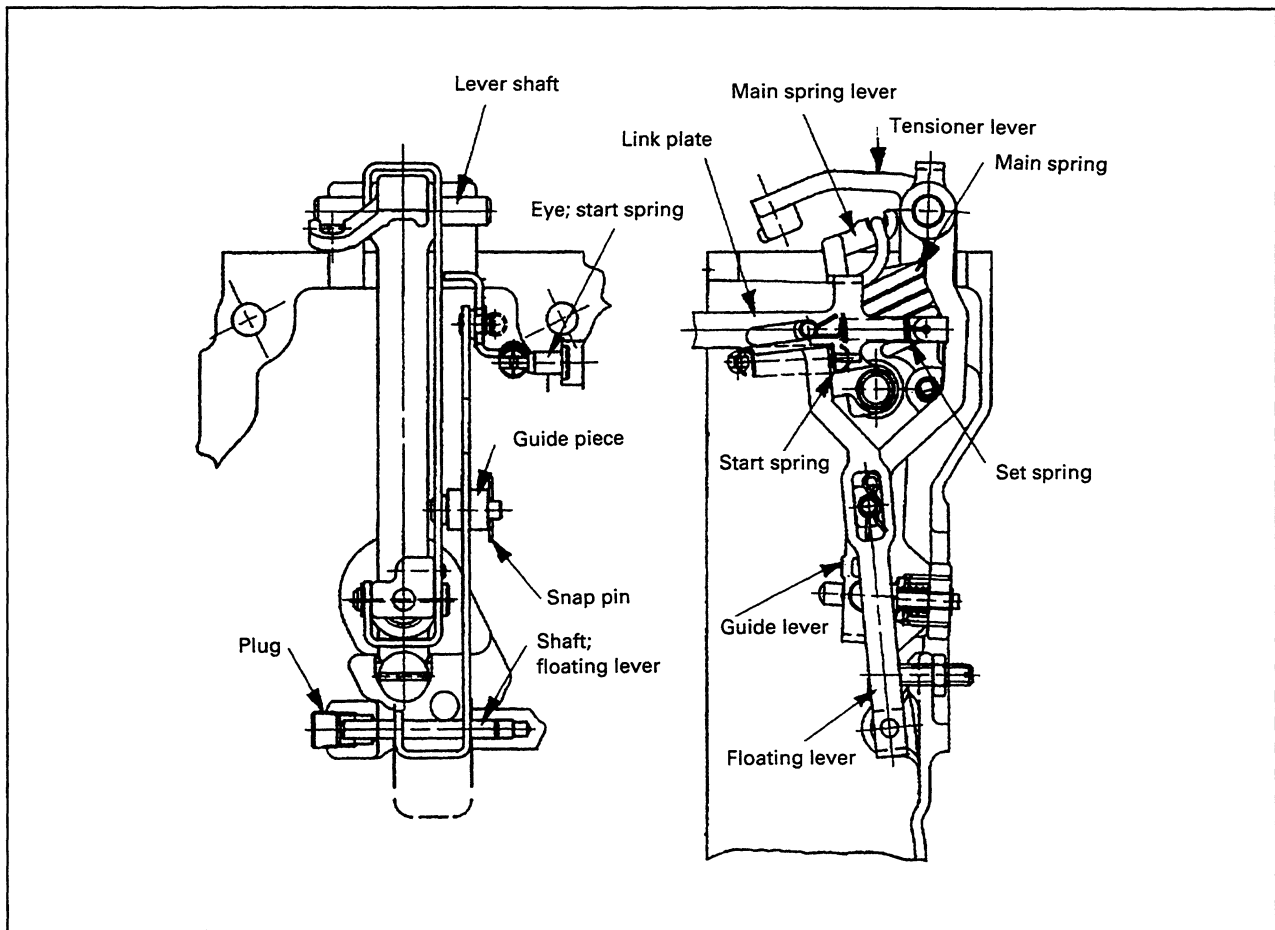


Fig. 197

8. Notes when assembling governor related components

- (1) When assembling components, apply engine oil to each slide (such as the end face of the lever, the hole in the shaft, and the periphery of the shaft).
- (2) Install the set spring securely to the groove of the pin connecting the floating lever, with much care to its assembling direction.
- (3) Confirm that each lever moves by its dead weight before installing the start spring.
- (4) After assembly, confirm that each lever moves smoothly.
And also confirm that each spring operates properly.

NOZZLE HOLDER ASSEMBLY



DISASSEMBLY

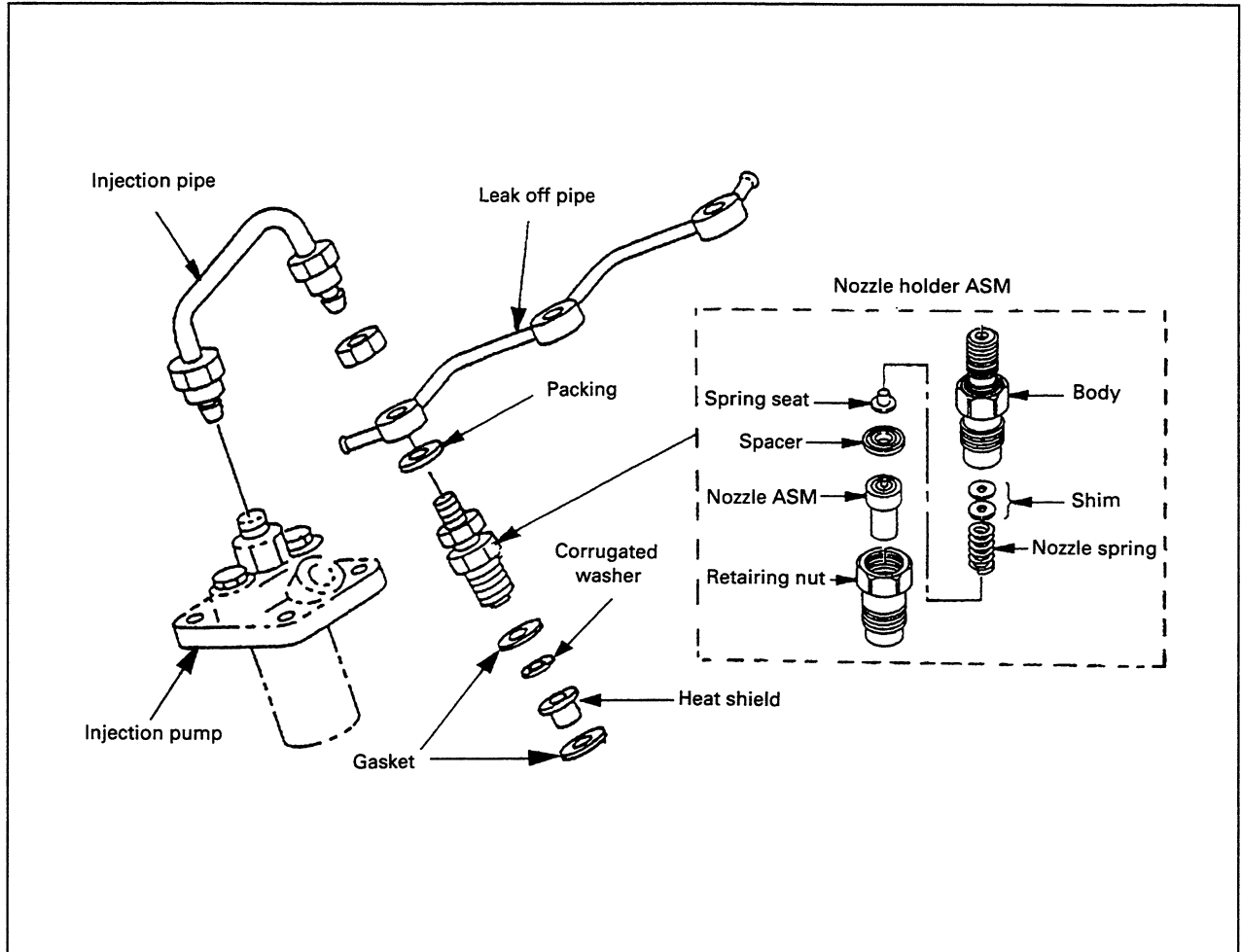


Fig. 198

NOZZLE ASSEMBLY

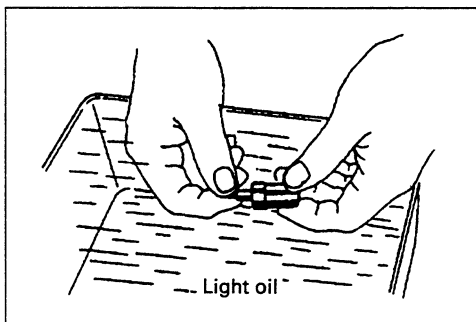


Fig. 199



Inspection and replacement

Place the removed nozzle in the clean light oil, disassemble it into the nozzle body and the needle valve and clean them thoroughly. Then check to see if the valve moves smoothly in the body.

When it does not move smoothly, repair or replace the nozzle.



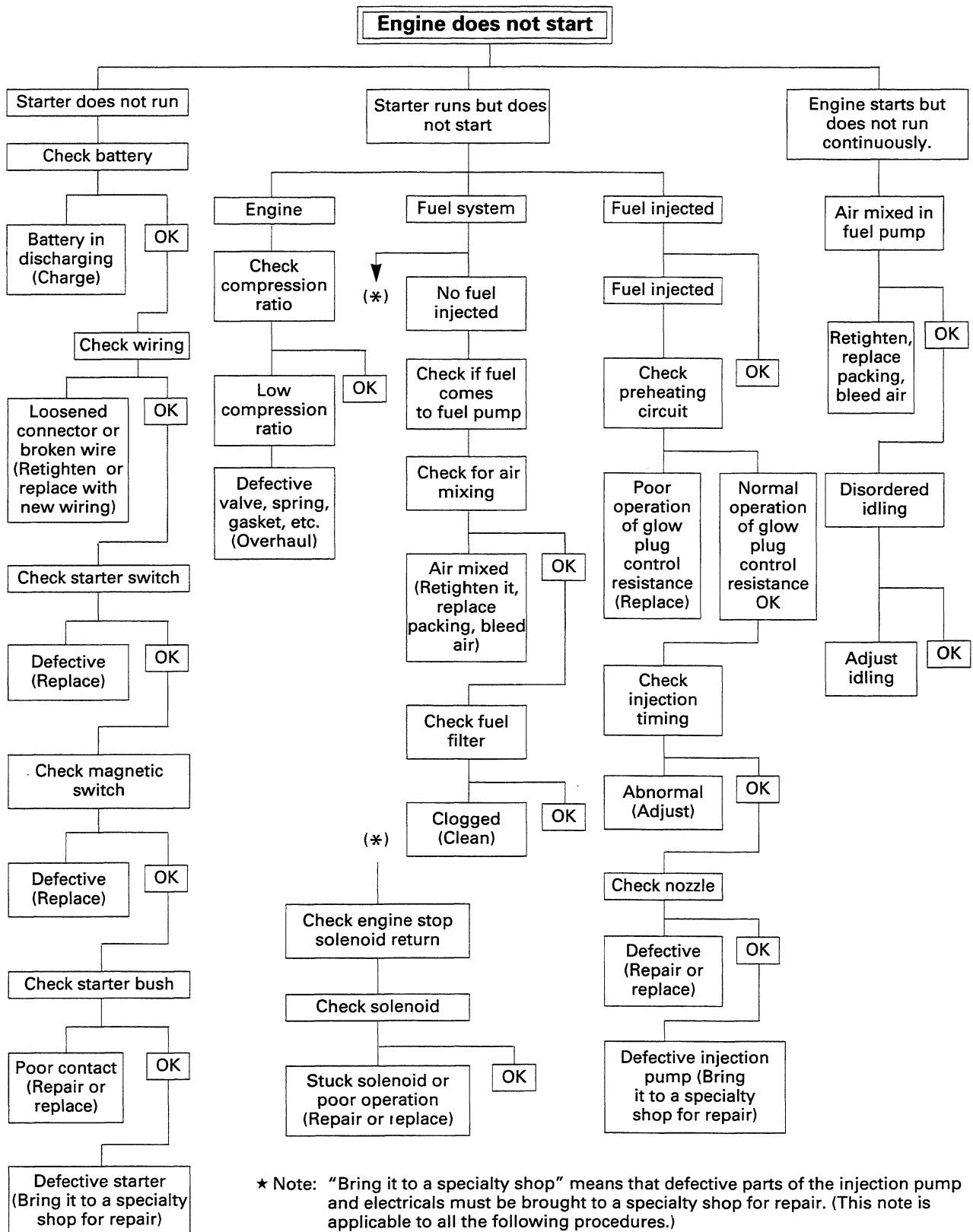
Adjustment

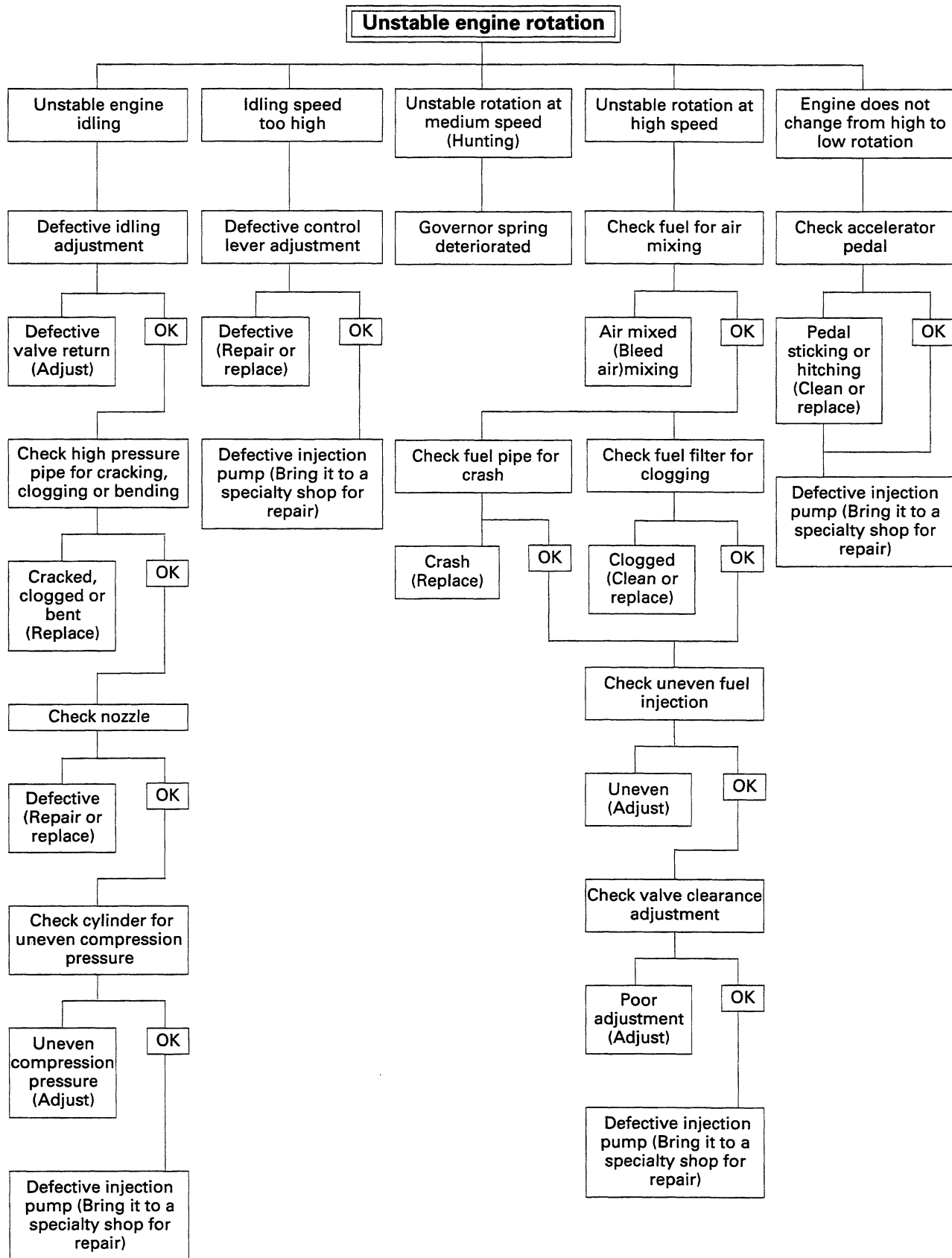
For the adjustment of the injection pressure and the spray condition of fuel, refer to Section 1 "INSPECTION AND SERVICE."

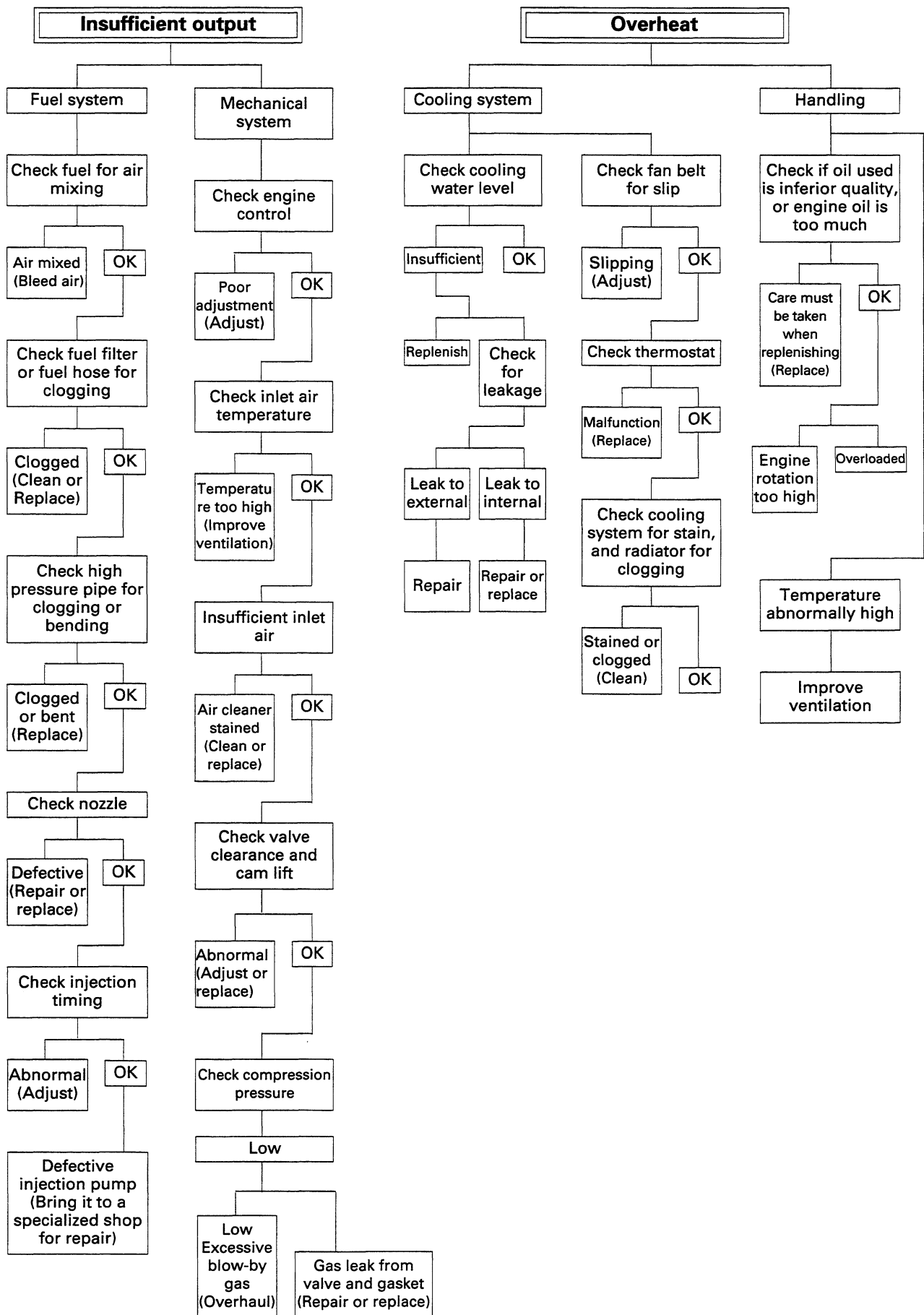
[illegible]

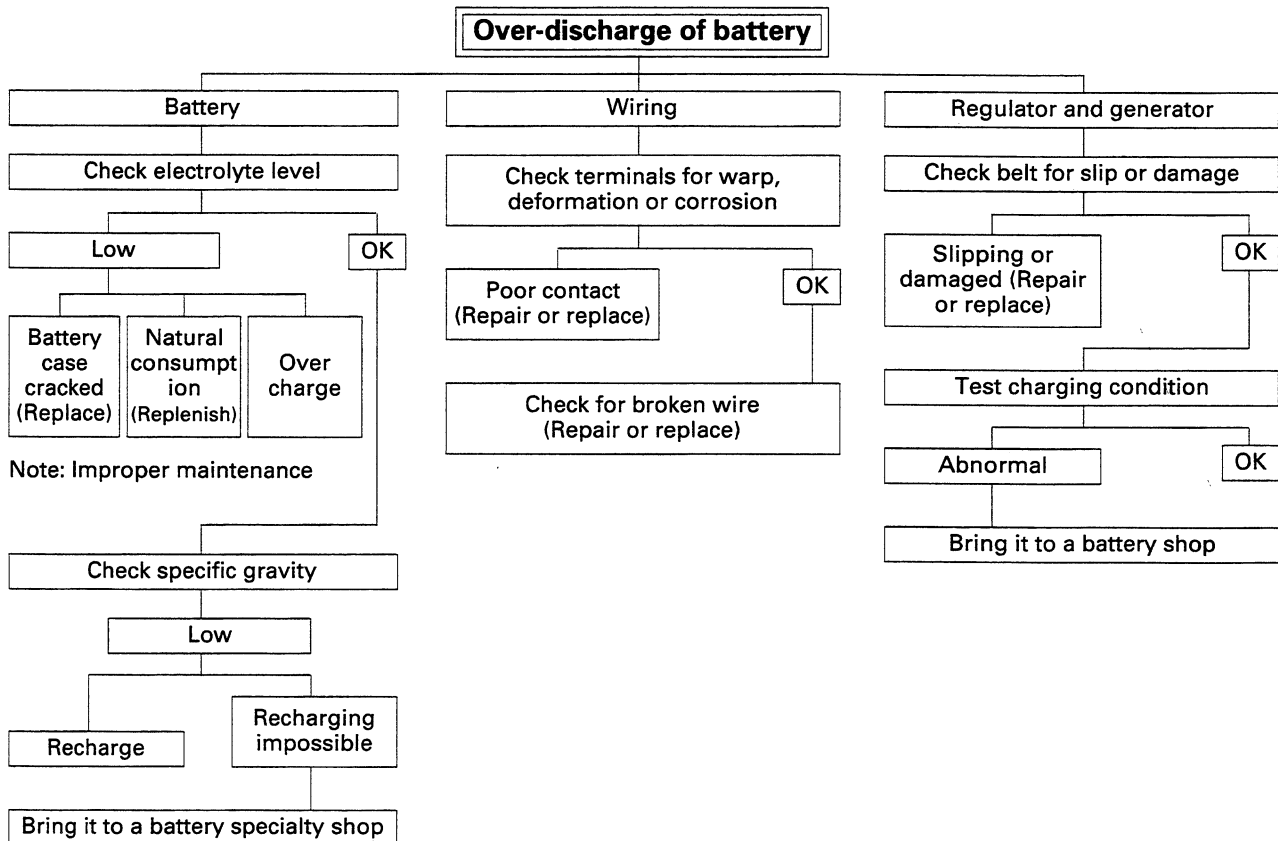
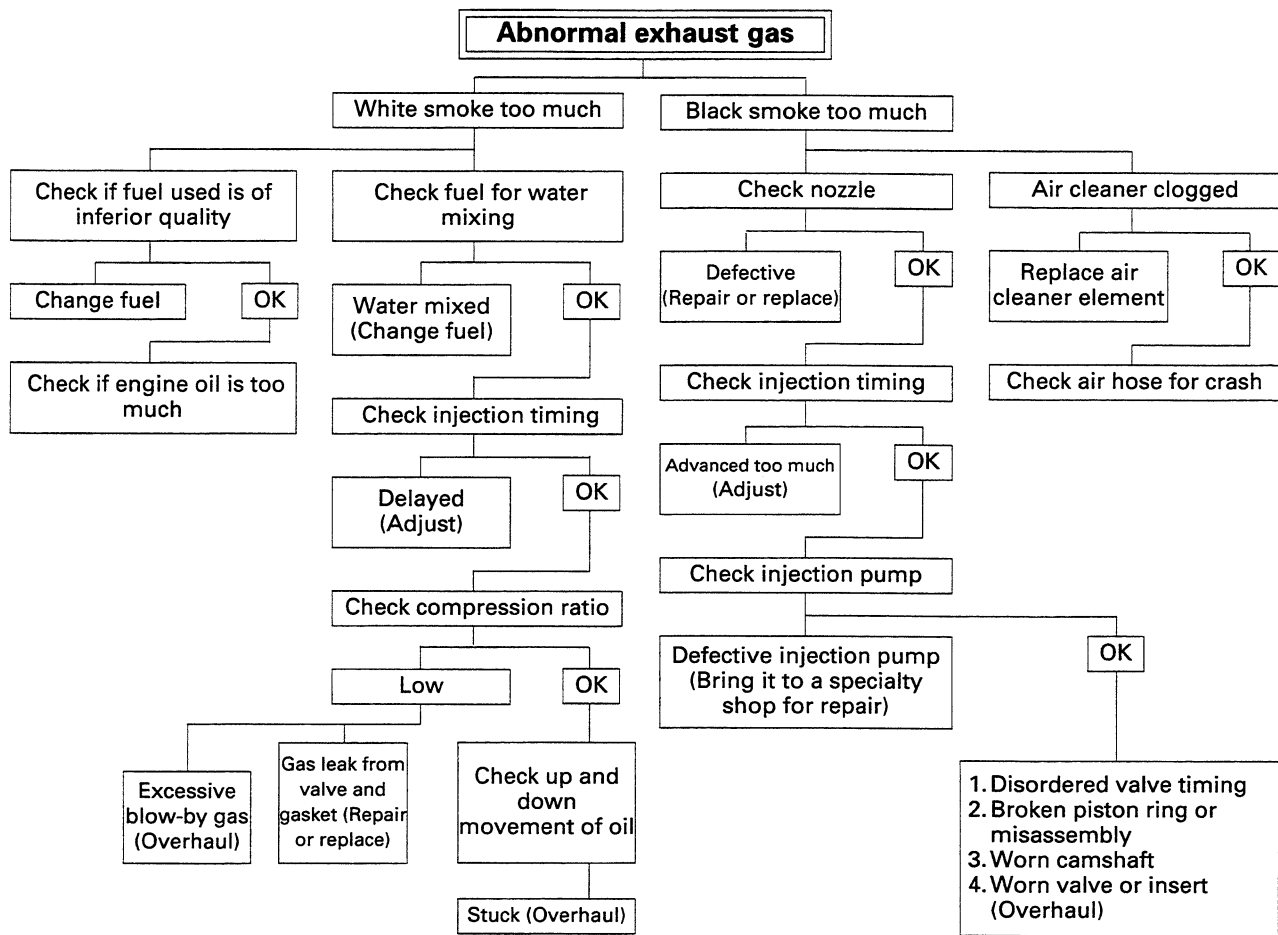
SECTION 6

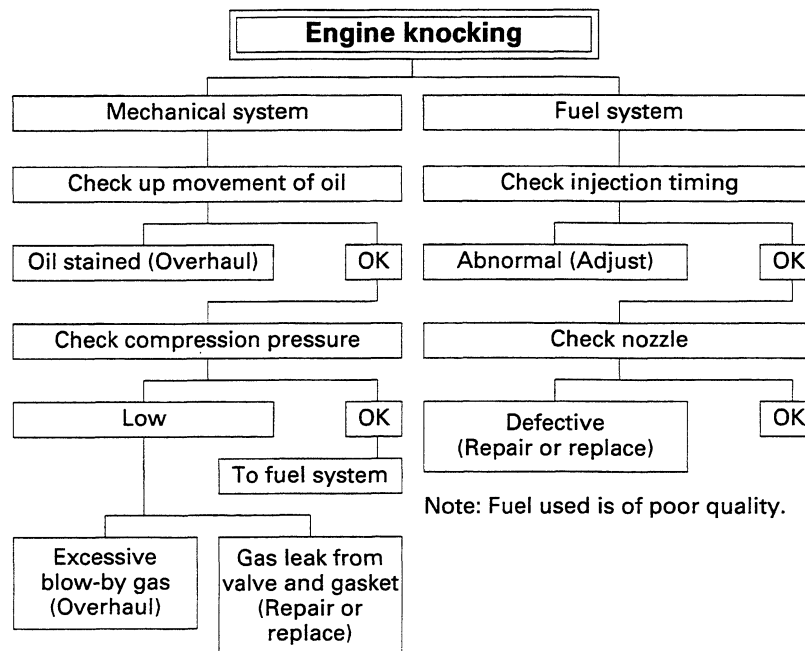
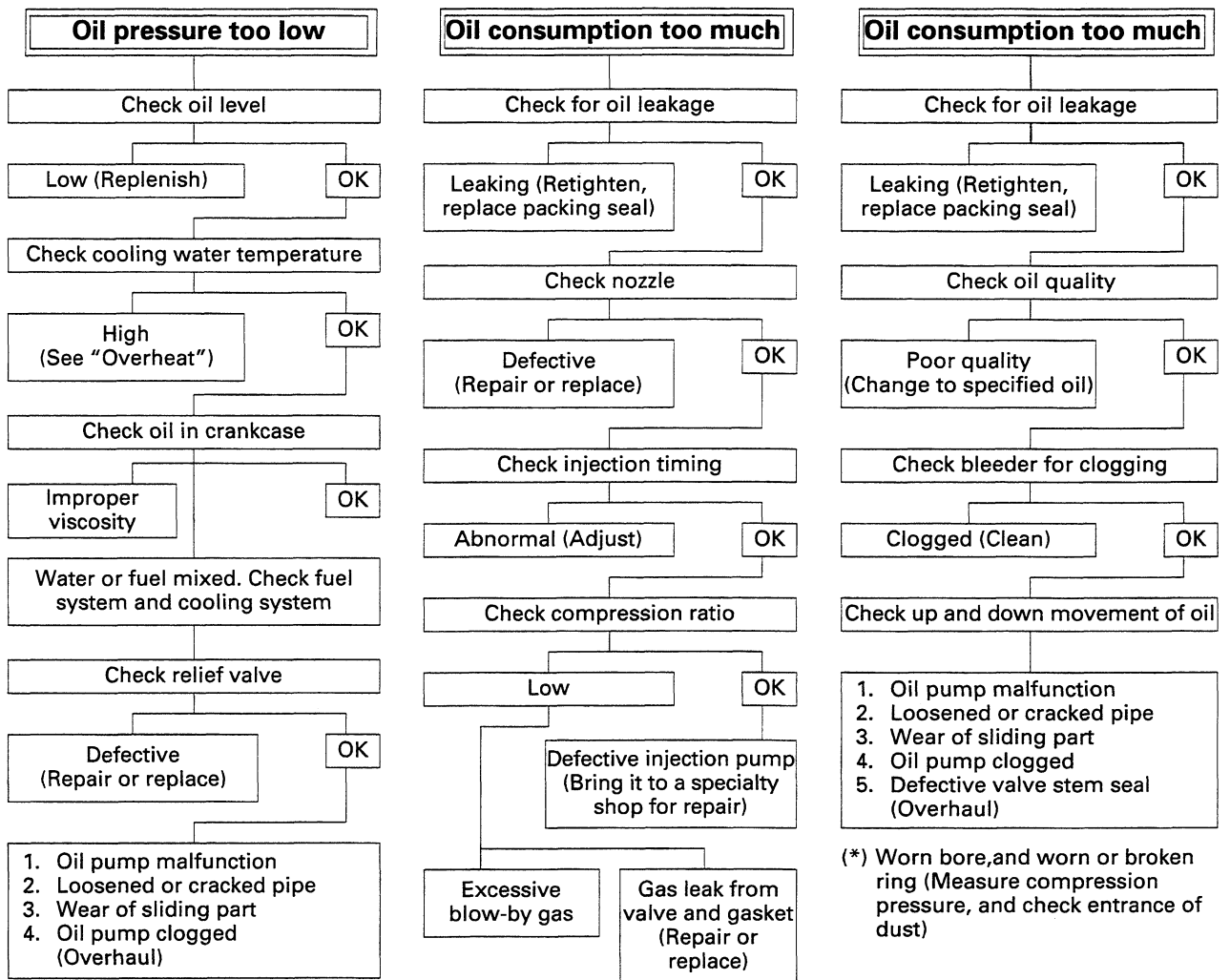
TROUBLESHOOTING












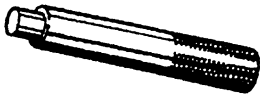

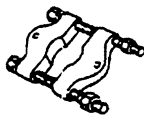



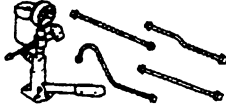
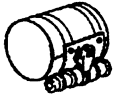


[illegible]

SECTION 7

SPECIAL TOOLS

The alphanumeric codes in parentheses “()” are part numbers assigned by special tool manufacturers.

| No. | Illustration | Part Number | Part Name | Page |
|-----|-------------------------------------------------------------------------------------|-------------------------------|----------------------------|------|
| 1. |  | | Valve spring compressor | — |
| 2. |  | 5-8840-2061-0 | Setting: Oil seal front | — |
| 3. |  | 5-8840-9004-0 (JKM-1006) | Setting: Oil seal rear | — |
| 4. |  | 5-8840-0007-0 (J-8092) | Drive handle | — |
| 5. |  | 5-8840-9007-0 (JKM-1009) | Setting: Valve guide seal | — |
| 6. |  | 5-8840-0015-0 (J-22912-01) | Remover bearing | — |
| 7. |  | 5-8840-2008-0 (J-29762) | Compression gauge | |
| 8. |  | 5-8840-2009-0 (J-26999-20) | Adapter: Compression gauge | |
| 9. |  | 5-8840-9015-0 (JKM-9004) | Oil filter wrench | |
| 10. |  | 5-8840-9016-0 (J-28829) | Tester: Nozzle | |
| 11. |  | 5-8840-9018-0 (J-8037) | Piston ring compressor | |

[illegible]

SECTION 8

CONVERSION TABLE

TABLE OF CONTENTS

| ITEM | PAGE |
|-------------------|------|
| LENGTH | 113 |
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| VOLUME | 115 |
| MASS | 117 |
| PRESSURE | 118 |
| TORQUE | 119 |
| TEMPERATURE | 120 |

LENGTH

MILLIMETERS TO INCHES

| mm | in. | mm | in. | mm | in. | mm | in. |
|----|--------|----|--------|----|--------|-----|--------|
| 1 | 0.0394 | 26 | 1.0236 | 51 | 2.0079 | 76 | 2.9921 |
| 2 | 0.0787 | 27 | 1.0630 | 52 | 2.0472 | 77 | 3.0315 |
| 3 | 0.1181 | 28 | 1.1024 | 53 | 2.0866 | 78 | 3.0709 |
| 4 | 0.1575 | 29 | 1.1417 | 54 | 2.1260 | 79 | 3.1102 |
| 5 | 0.1969 | 30 | 1.1811 | 55 | 2.1654 | 80 | 3.1496 |
| 6 | 0.2362 | 31 | 1.2205 | 56 | 2.2047 | 81 | 3.1890 |
| 7 | 0.2756 | 32 | 1.2598 | 57 | 2.2441 | 82 | 3.2283 |
| 8 | 0.3150 | 33 | 1.2992 | 58 | 2.2835 | 83 | 3.2677 |
| 9 | 0.3543 | 34 | 1.3386 | 59 | 2.3228 | 84 | 3.3071 |
| 10 | 0.3937 | 35 | 1.3780 | 60 | 2.3622 | 85 | 3.3465 |
| 11 | 0.4331 | 36 | 1.4173 | 61 | 2.4016 | 86 | 3.3858 |
| 12 | 0.4724 | 37 | 1.4567 | 62 | 2.4409 | 87 | 3.4252 |
| 13 | 0.5118 | 38 | 1.4961 | 63 | 2.4803 | 88 | 3.4646 |
| 14 | 0.5512 | 39 | 1.5354 | 64 | 2.5197 | 89 | 3.5039 |
| 15 | 0.5906 | 40 | 1.5748 | 65 | 2.5591 | 90 | 3.5433 |
| 16 | 0.6299 | 41 | 1.6142 | 66 | 2.5984 | 91 | 3.5827 |
| 17 | 0.6693 | 42 | 1.6535 | 67 | 2.6378 | 92 | 3.6220 |
| 18 | 0.7087 | 43 | 1.6929 | 68 | 2.6772 | 93 | 3.6614 |
| 19 | 0.7480 | 44 | 1.7323 | 69 | 2.7165 | 94 | 3.7008 |
| 20 | 0.7874 | 45 | 1.7717 | 70 | 2.7559 | 95 | 3.7402 |
| 21 | 0.8268 | 46 | 1.8110 | 71 | 2.7953 | 96 | 3.7795 |
| 22 | 0.8661 | 47 | 1.8504 | 72 | 2.8346 | 97 | 3.8189 |
| 23 | 0.9055 | 48 | 1.8898 | 73 | 2.8740 | 98 | 3.8583 |
| 24 | 0.9449 | 49 | 1.9291 | 74 | 2.9134 | 99 | 3.8976 |
| 25 | 0.9843 | 50 | 1.9685 | 75 | 2.9528 | 100 | 3.9370 |

| | | | | | | | |
|-----|--------|-----|--------|-----|--------|-----|--------|
| 101 | 3.9764 | 111 | 4.3701 | 121 | 4.7638 | 131 | 5.1575 |
| 102 | 4.0157 | 112 | 4.4094 | 122 | 4.8031 | 132 | 5.1969 |
| 103 | 4.0551 | 113 | 4.4488 | 123 | 4.8425 | 133 | 5.2362 |
| 104 | 4.0945 | 114 | 4.4882 | 124 | 4.8819 | 134 | 5.2756 |
| 105 | 4.1339 | 115 | 4.5276 | 125 | 4.9213 | 135 | 5.3150 |
| 106 | 4.1732 | 116 | 4.5669 | 126 | 4.9606 | 136 | 5.3543 |
| 107 | 4.2126 | 117 | 4.6063 | 127 | 5.0000 | 137 | 5.3937 |
| 108 | 4.2520 | 118 | 4.6457 | 128 | 5.0394 | 138 | 5.4331 |
| 109 | 4.2913 | 119 | 4.6850 | 129 | 5.0787 | 139 | 5.4724 |

INCHES TO MILLIMETERS

| in. | mm | in. | mm |
|-------|---------|-------|---------|
| 1/64 | 0.3969 | 33/64 | 13.0969 |
| 1/32 | 0.7938 | 17/32 | 13.4938 |
| 3/64 | 1.1906 | 35/64 | 13.8906 |
| 1/16 | 1.5875 | 9/16 | 14.2875 |
| 5/64 | 1.9844 | 37/64 | 14.6844 |
| 3/32 | 2.3813 | 19/32 | 15.0813 |
| 7/64 | 2.7781 | 39/64 | 15.4781 |
| 1/8 | 3.1750 | 5/8 | 15.8750 |
| 9/64 | 3.5719 | 41/64 | 16.2719 |
| 5/32 | 3.9688 | 21/32 | 16.6688 |
| 11/64 | 4.3656 | 43/64 | 17.0656 |
| 3/16 | 4.7625 | 11/16 | 17.4625 |
| 13/64 | 5.1594 | 45/64 | 17.8594 |
| 7/32 | 5.5563 | 23/32 | 18.2563 |
| 15/64 | 5.9531 | 47/64 | 18.6531 |
| 1/4 | 6.3500 | 3/4 | 19.0500 |
| 17/64 | 6.7469 | 49/64 | 19.4469 |
| 9/32 | 7.1438 | 25/32 | 19.8438 |
| 19/64 | 7.5406 | 51/64 | 20.2406 |
| 5/16 | 7.9375 | 13/16 | 20.6375 |
| 21/64 | 8.3344 | 53/64 | 21.0344 |
| 11/32 | 8.7313 | 27/32 | 21.4313 |
| 23/64 | 9.1281 | 55/64 | 21.8281 |
| 3/8 | 9.5250 | 7/8 | 22.2250 |
| 25/64 | 9.9219 | 57/64 | 22.6219 |
| 13/32 | 10.3188 | 29/32 | 23.0188 |
| 27/64 | 10.7156 | 59/64 | 23.4156 |
| 7/16 | 11.1125 | 15/16 | 23.8125 |
| 29/64 | 11.5094 | 61/64 | 24.2094 |
| 15/32 | 11.9063 | 31/32 | 24.6063 |
| 31/64 | 12.3031 | 63/64 | 25.0031 |
| 1/2 | 12.7000 | 1 | 25.4000 |

114 CONVERSION TABLE

LENGTH

FEET TO METERS

| ft. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | ft. |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-----|
| | m | m | m | m | m | m | m | m | m | m | |
| — | — | 0.305 | 0.610 | 0.914 | 1.219 | 1.524 | 1.829 | 2.134 | 2.438 | 2.743 | — |
| 10 | 3.048 | 3.353 | 3.658 | 3.962 | 4.267 | 4.572 | 4.877 | 5.182 | 5.486 | 5.791 | 10 |
| 20 | 6.096 | 6.401 | 6.706 | 7.010 | 7.315 | 7.620 | 7.925 | 8.230 | 8.534 | 8.839 | 20 |
| 30 | 9.144 | 9.449 | 9.754 | 10.058 | 10.363 | 10.668 | 10.973 | 11.278 | 11.582 | 11.887 | 30 |
| 40 | 12.192 | 12.497 | 12.802 | 13.106 | 13.411 | 13.716 | 14.021 | 14.326 | 14.630 | 14.935 | 40 |
| 50 | 15.240 | 15.545 | 15.850 | 16.154 | 16.459 | 16.764 | 17.069 | 17.374 | 17.678 | 17.983 | 50 |
| 60 | 18.288 | 18.593 | 18.898 | 19.202 | 19.507 | 19.812 | 20.117 | 20.422 | 20.726 | 21.031 | 60 |
| 70 | 21.336 | 21.641 | 21.946 | 22.250 | 22.555 | 22.860 | 23.165 | 23.470 | 23.774 | 24.079 | 70 |
| 80 | 24.384 | 24.689 | 24.994 | 25.298 | 25.603 | 25.908 | 26.213 | 26.518 | 26.822 | 27.127 | 80 |
| 90 | 27.432 | 27.737 | 28.042 | 28.346 | 28.651 | 28.956 | 29.261 | 29.566 | 29.870 | 30.175 | 90 |
| 100 | 30.480 | 30.785 | 31.090 | 31.394 | 31.699 | 32.004 | 32.309 | 32.614 | 32.918 | 33.223 | 100 |

METERS TO FEET

| m | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
|-----|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----|
| | ft. | ft. | ft. | ft. | ft. | ft. | ft. | ft. | ft. | ft. | |
| — | — | 3.2808 | 6.5617 | 9.8425 | 13.1234 | 16.4042 | 19.6850 | 22.9659 | 26.2467 | 29.5276 | — |
| 10 | 32.8084 | 36.0892 | 39.3701 | 42.6509 | 45.9318 | 49.2126 | 52.4934 | 55.7743 | 59.0551 | 62.3360 | 10 |
| 20 | 65.6168 | 68.8976 | 72.1785 | 75.4593 | 78.7402 | 82.0210 | 85.3018 | 88.5827 | 91.8635 | 95.1444 | 20 |
| 30 | 98.4252 | 101.7060 | 104.9869 | 108.2677 | 111.5486 | 114.8294 | 118.1102 | 121.3911 | 124.6719 | 127.9528 | 30 |
| 40 | 131.2336 | 134.5144 | 137.7953 | 141.0761 | 144.3570 | 147.6378 | 150.9186 | 154.1995 | 157.4803 | 160.7612 | 40 |
| 50 | 164.0420 | 167.3228 | 170.6037 | 173.8845 | 177.1654 | 180.4462 | 183.7270 | 187.0079 | 190.2887 | 193.5696 | 50 |
| 60 | 196.8504 | 200.1312 | 203.4121 | 206.6929 | 209.9738 | 213.2546 | 216.5354 | 219.8163 | 223.0971 | 226.3780 | 60 |
| 70 | 229.6588 | 232.9396 | 236.2205 | 239.5013 | 242.7822 | 246.0630 | 249.3438 | 252.6247 | 255.9055 | 259.1864 | 70 |
| 80 | 262.4672 | 265.7480 | 269.0289 | 272.3097 | 275.5906 | 278.8714 | 282.1522 | 285.4331 | 288.7139 | 291.9948 | 80 |
| 90 | 295.2756 | 298.5564 | 301.8373 | 305.1181 | 308.3990 | 311.6798 | 314.9606 | 318.2415 | 321.5223 | 324.8032 | 90 |
| 100 | 328.0840 | 331.3648 | 334.6457 | 337.9265 | 341.2074 | 344.4882 | 347.7690 | 351.0499 | 354.3307 | 357.6116 | 100 |

MILES TO KILOMETERS

| miles | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
|-------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|-----|
| | km | km | km | km | km | km | km | km | km | km | |
| — | — | 1.609 | 3.219 | 4.828 | 6.437 | 8.047 | 9.656 | 11.265 | 12.875 | 14.484 | — |
| 10 | 16.093 | 17.703 | 19.312 | 20.921 | 22.531 | 24.140 | 25.749 | 27.359 | 28.968 | 30.577 | 10 |
| 20 | 32.187 | 33.796 | 35.405 | 37.015 | 38.624 | 40.234 | 41.843 | 43.452 | 45.062 | 46.671 | 20 |
| 30 | 48.280 | 49.890 | 51.499 | 53.108 | 54.718 | 56.327 | 57.936 | 59.546 | 61.155 | 62.764 | 30 |
| 40 | 64.374 | 65.983 | 67.592 | 69.202 | 70.811 | 72.420 | 74.030 | 75.639 | 77.248 | 78.858 | 40 |
| 50 | 80.467 | 82.076 | 83.686 | 85.295 | 86.904 | 88.514 | 90.123 | 91.732 | 93.342 | 94.951 | 50 |
| 60 | 96.560 | 98.170 | 99.779 | 101.388 | 102.998 | 104.607 | 106.216 | 107.826 | 109.435 | 111.044 | 60 |
| 70 | 112.654 | 114.263 | 115.872 | 117.482 | 119.091 | 120.701 | 122.310 | 123.919 | 125.529 | 127.138 | 70 |
| 80 | 128.747 | 130.357 | 131.966 | 133.575 | 135.185 | 136.794 | 138.403 | 140.013 | 141.622 | 143.231 | 80 |
| 90 | 144.841 | 146.450 | 148.059 | 149.669 | 151.278 | 152.887 | 154.497 | 156.106 | 157.715 | 159.325 | 90 |
| 100 | 160.934 | 162.543 | 164.153 | 165.762 | 167.371 | 168.981 | 170.590 | 172.199 | 173.809 | 175.418 | 100 |

KILOMETERS TO MILES

| km | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-----|
| | miles | miles | miles | miles | miles | miles | miles | miles | miles | miles | |
| — | — | 0.621 | 1.243 | 1.864 | 2.485 | 3.107 | 3.728 | 4.350 | 4.971 | 5.592 | — |
| 10 | 6.214 | 6.835 | 7.456 | 8.078 | 8.699 | 9.321 | 9.942 | 10.563 | 11.185 | 11.806 | 10 |
| 20 | 12.427 | 13.049 | 13.670 | 14.292 | 14.913 | 15.534 | 16.156 | 16.777 | 17.398 | 18.020 | 20 |
| 30 | 18.641 | 19.262 | 19.884 | 20.505 | 21.127 | 21.748 | 22.369 | 22.991 | 23.612 | 24.233 | 30 |
| 40 | 24.855 | 25.476 | 26.098 | 26.719 | 27.340 | 27.962 | 28.583 | 29.204 | 29.826 | 30.447 | 40 |
| 50 | 31.069 | 31.690 | 32.311 | 32.933 | 33.554 | 34.175 | 34.797 | 35.418 | 36.039 | 36.661 | 50 |
| 60 | 37.282 | 37.904 | 38.525 | 39.146 | 39.768 | 40.389 | 41.010 | 41.632 | 42.253 | 42.875 | 60 |
| 70 | 43.496 | 44.117 | 44.739 | 45.360 | 45.981 | 46.603 | 47.224 | 47.845 | 48.467 | 49.088 | 70 |
| 80 | 49.710 | 50.331 | 50.952 | 51.574 | 52.195 | 52.816 | 53.438 | 54.059 | 54.681 | 55.302 | 80 |
| 90 | 55.923 | 56.545 | 57.166 | 57.787 | 58.409 | 59.030 | 59.652 | 60.273 | 60.894 | 61.516 | 90 |
| 100 | 62.137 | 62.758 | 63.380 | 64.001 | 64.622 | 65.244 | 65.865 | 66.487 | 67.108 | 67.729 | 100 |

AREA**SQUARE INCHES TO SQUARE CENTIMETERS**

| in ² | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | in ² |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| | cm ² | cm ² | cm ² | cm ² | cm ² | cm ² | cm ² | cm ² | cm ² | cm ² | |
| — | — | 6.452 | 12.903 | 19.355 | 25.806 | 32.258 | 38.710 | 45.161 | 51.613 | 58.064 | — |
| 10 | 64.516 | 70.968 | 77.419 | 83.871 | 90.322 | 96.774 | 103.226 | 109.677 | 116.129 | 122.580 | 10 |
| 20 | 129.032 | 135.484 | 141.935 | 148.387 | 154.838 | 161.290 | 167.742 | 174.193 | 180.645 | 187.096 | 20 |
| 30 | 193.548 | 200.000 | 206.451 | 212.903 | 219.354 | 225.806 | 232.258 | 238.709 | 245.161 | 251.612 | 30 |
| 40 | 258.064 | 264.516 | 270.967 | 277.419 | 283.870 | 290.322 | 296.774 | 303.225 | 309.677 | 316.128 | 40 |
| 50 | 322.580 | 329.032 | 335.483 | 341.935 | 348.386 | 354.838 | 361.290 | 367.741 | 374.193 | 380.644 | 50 |
| 60 | 387.096 | 393.548 | 399.999 | 406.451 | 412.902 | 419.354 | 425.806 | 432.257 | 438.709 | 445.160 | 60 |
| 70 | 451.612 | 458.064 | 464.515 | 470.967 | 477.418 | 483.870 | 490.322 | 496.773 | 503.225 | 509.676 | 70 |
| 80 | 516.128 | 522.580 | 529.031 | 535.483 | 541.934 | 548.386 | 554.838 | 561.289 | 567.741 | 574.192 | 80 |
| 90 | 580.644 | 587.096 | 593.547 | 599.999 | 606.450 | 612.902 | 619.354 | 625.805 | 632.257 | 638.708 | 90 |
| 100 | 645.160 | 651.612 | 658.063 | 664.515 | 670.966 | 677.418 | 683.870 | 690.321 | 696.773 | 703.224 | 100 |

SQUARE CENTIMETERS TO SQUARE INCHES

| cm ² | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | cm ² |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| | in ² | in ² | in ² | in ² | in ² | in ² | in ² | in ² | in ² | in ² | |
| — | — | 0.155 | 0.310 | 0.465 | 0.620 | 0.775 | 0.930 | 1.085 | 1.240 | 1.395 | — |
| 10 | 1.550 | 1.705 | 1.860 | 2.015 | 2.170 | 2.325 | 2.480 | 2.635 | 2.790 | 2.945 | 10 |
| 20 | 3.100 | 3.255 | 3.410 | 3.565 | 3.720 | 3.875 | 4.030 | 4.185 | 4.340 | 4.495 | 20 |
| 30 | 4.650 | 4.805 | 4.960 | 5.115 | 5.270 | 5.425 | 5.580 | 5.735 | 5.890 | 6.045 | 30 |
| 40 | 6.200 | 6.355 | 6.510 | 6.665 | 6.820 | 6.975 | 7.130 | 7.285 | 7.440 | 7.595 | 40 |
| 50 | 7.750 | 7.905 | 8.060 | 8.215 | 8.370 | 8.525 | 8.680 | 8.835 | 8.990 | 9.145 | 50 |
| 60 | 9.300 | 9.455 | 9.610 | 9.765 | 9.920 | 10.075 | 10.230 | 10.385 | 10.540 | 10.695 | 60 |
| 70 | 10.850 | 11.005 | 11.160 | 11.315 | 11.470 | 11.625 | 11.780 | 11.935 | 12.090 | 12.245 | 70 |
| 80 | 12.400 | 12.555 | 12.710 | 12.865 | 13.020 | 13.175 | 13.330 | 13.485 | 13.640 | 13.795 | 80 |
| 90 | 13.950 | 14.105 | 14.260 | 14.415 | 14.570 | 14.725 | 14.880 | 15.035 | 15.190 | 15.345 | 90 |
| 100 | 15.500 | 15.655 | 15.810 | 15.965 | 16.120 | 16.275 | 16.430 | 16.585 | 16.740 | 16.895 | 100 |

VOLUME**CUBIC INCHES TO CUBIC CENTIMETERS**

| in ³ | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | in ³ |
|-----------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|-----------------|
| | cm ³ (cc) | cm ³ (cc) | cm ³ (cc) | cm ³ (cc) | cm ³ (cc) | cm ³ (cc) | cm ³ (cc) | cm ³ (cc) | cm ³ (cc) | cm ³ (cc) | |
| — | — | 16.387 | 32.774 | 49.161 | 65.548 | 81.935 | 98.322 | 114.709 | 131.097 | 147.484 | — |
| 10 | 163.871 | 180.258 | 196.645 | 213.032 | 229.419 | 245.806 | 262.193 | 278.580 | 294.967 | 311.354 | 10 |
| 20 | 327.741 | 344.128 | 360.515 | 376.902 | 393.290 | 409.677 | 426.064 | 442.451 | 458.838 | 475.225 | 20 |
| 30 | 491.612 | 507.999 | 524.386 | 540.773 | 557.160 | 573.547 | 589.934 | 606.321 | 622.708 | 639.095 | 30 |
| 40 | 655.483 | 671.870 | 688.257 | 704.644 | 721.031 | 737.418 | 753.805 | 770.192 | 786.579 | 802.966 | 40 |
| 50 | 819.353 | 835.740 | 852.127 | 868.514 | 884.901 | 901.289 | 917.676 | 934.063 | 950.450 | 966.837 | 50 |
| 60 | 983.224 | 999.611 | 1015.998 | 1032.385 | 1048.772 | 1065.159 | 1081.546 | 1097.933 | 1114.320 | 1130.707 | 60 |
| 70 | 1147.094 | 1163.482 | 1179.869 | 1196.256 | 1212.643 | 1229.030 | 1245.417 | 1261.804 | 1278.191 | 1294.578 | 70 |
| 80 | 1310.965 | 1327.352 | 1343.739 | 1360.126 | 1376.513 | 1392.900 | 1409.288 | 1425.675 | 1442.062 | 1458.449 | 80 |
| 90 | 1474.836 | 1491.223 | 1507.610 | 1523.997 | 1540.384 | 1556.771 | 1573.158 | 1589.545 | 1605.932 | 1622.319 | 90 |
| 100 | 1638.706 | 1655.093 | 1671.481 | 1687.868 | 1704.255 | 1720.642 | 1737.029 | 1753.416 | 1769.803 | 1786.190 | 100 |

CUBIC CENTIMETERS TO CUBIC INCHES

| cm ³ (cc) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | cm ³ (cc) |
|----------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|----------------------|
| | in ³ | in ³ | in ³ | in ³ | in ³ | in ³ | in ³ | in ³ | in ³ | in ³ | |
| — | — | 0.0610 | 0.1220 | 0.1831 | 0.2441 | 0.3051 | 0.3661 | 0.4272 | 0.4882 | 0.5492 | — |
| 10 | 0.6102 | 0.6713 | 0.7323 | 0.7933 | 0.8543 | 0.9153 | 0.9764 | 1.0374 | 1.0984 | 1.1594 | 10 |
| 20 | 1.2205 | 1.2815 | 1.3425 | 1.4035 | 1.4646 | 1.5256 | 1.5866 | 1.6476 | 1.7086 | 1.7697 | 20 |
| 30 | 1.8307 | 1.8917 | 1.9527 | 2.0138 | 2.0748 | 2.1358 | 2.1968 | 2.2579 | 2.3189 | 2.3799 | 30 |
| 40 | 2.4409 | 2.5019 | 2.5630 | 2.6240 | 2.6850 | 2.7460 | 2.8071 | 2.8681 | 2.9291 | 2.9901 | 40 |
| 50 | 3.0512 | 3.1122 | 3.1732 | 3.2342 | 3.2952 | 3.3563 | 3.4173 | 3.4783 | 3.5393 | 3.6004 | 50 |
| 60 | 3.6614 | 3.7224 | 3.7834 | 3.8444 | 3.9055 | 3.9665 | 4.0275 | 4.0885 | 4.1496 | 4.2106 | 60 |
| 70 | 4.2716 | 4.3326 | 4.3937 | 4.4547 | 4.5157 | 4.5767 | 4.6377 | 4.6988 | 4.7598 | 4.8208 | 70 |
| 80 | 4.8818 | 4.9429 | 5.0039 | 5.0649 | 5.1259 | 5.1870 | 5.2480 | 5.3090 | 5.3700 | 5.4310 | 80 |
| 90 | 5.4921 | 5.5531 | 5.6141 | 5.6751 | 5.7362 | 5.7972 | 5.8582 | 5.9192 | 5.9803 | 6.0413 | 90 |
| 100 | 6.1023 | 6.1633 | 6.2243 | 6.2854 | 6.3464 | 6.4074 | 6.4684 | 6.5295 | 6.5905 | 6.6515 | 100 |

116 CONVERSION TABLE

VOLUME

GALLONS (U.S.) TO LITERS

| U.S. gal. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | U.S.gal. |
|-----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| | liters | liters | liters | liters | liters | liters | liters | liters | liters | liters | |
| — | — | 3.7854 | 7.5709 | 11.3563 | 15.1417 | 18.9271 | 22.7126 | 26.4980 | 30.2834 | 34.0688 | — |
| 10 | 37.8543 | 41.6397 | 45.4251 | 49.2106 | 52.9960 | 56.7814 | 60.5668 | 64.3523 | 68.1377 | 71.9231 | 10 |
| 20 | 75.7085 | 79.4940 | 83.2794 | 87.0648 | 90.8502 | 94.6357 | 98.4211 | 102.2065 | 105.9920 | 109.7774 | 20 |
| 30 | 113.5628 | 117.3482 | 121.1337 | 124.9191 | 128.7045 | 132.4899 | 136.2754 | 140.0608 | 143.8462 | 147.6317 | 30 |
| 40 | 151.4171 | 155.2025 | 158.9879 | 162.7734 | 166.5588 | 170.3442 | 174.1296 | 177.9151 | 181.7005 | 185.4859 | 40 |
| 50 | 189.2714 | 193.0568 | 196.8422 | 200.6276 | 204.4131 | 208.1985 | 211.9839 | 215.7693 | 219.5548 | 223.3402 | 50 |
| 60 | 227.1256 | 230.9110 | 234.6965 | 238.4819 | 242.2673 | 246.0528 | 249.8382 | 253.6236 | 257.4090 | 261.1945 | 60 |
| 70 | 264.9799 | 268.7653 | 272.5507 | 276.3362 | 280.1216 | 283.9070 | 287.6925 | 291.4779 | 295.2633 | 299.0487 | 70 |
| 80 | 302.8342 | 306.6196 | 310.4050 | 314.1904 | 317.9759 | 321.7613 | 325.5467 | 329.3321 | 333.1176 | 336.9030 | 80 |
| 90 | 340.6884 | 344.4739 | 348.2593 | 352.0447 | 355.8301 | 359.6156 | 363.4010 | 367.1864 | 370.9718 | 374.7573 | 90 |
| 100 | 378.5427 | 382.3281 | 386.1136 | 389.8990 | 393.6844 | 397.4698 | 401.2553 | 405.0407 | 408.8261 | 412.6115 | 100 |

LITERS TO GALLONS (U.S.)

| liters | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | liters |
|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------|
| | gal. | gal. | gal. | gal. | gal. | gal. | gal. | gal. | gal. | gal. | |
| — | — | 0.2642 | 0.5283 | 0.7925 | 1.0567 | 1.3209 | 1.5850 | 1.8492 | 2.1134 | 2.3775 | — |
| 10 | 2.6417 | 2.9059 | 3.1701 | 3.4342 | 3.6984 | 3.9626 | 4.2268 | 4.4909 | 4.7551 | 5.0193 | 10 |
| 20 | 5.2834 | 5.5476 | 5.8118 | 6.0760 | 6.3401 | 6.6043 | 6.8685 | 7.1326 | 7.3968 | 7.6610 | 20 |
| 30 | 7.9252 | 8.1893 | 8.4535 | 8.7177 | 8.9818 | 9.2460 | 9.5102 | 9.7744 | 10.0385 | 10.3027 | 30 |
| 40 | 10.5669 | 10.8311 | 11.0952 | 11.3594 | 11.6236 | 11.8877 | 12.1519 | 12.4161 | 12.6803 | 12.9444 | 40 |
| 50 | 13.2086 | 13.4728 | 13.7369 | 14.0011 | 14.2653 | 14.5295 | 14.7936 | 15.0578 | 15.3220 | 15.5861 | 50 |
| 60 | 15.8503 | 16.1145 | 16.3787 | 16.6428 | 16.9070 | 17.1712 | 17.4354 | 17.6995 | 17.9637 | 18.2279 | 60 |
| 70 | 18.4920 | 18.7562 | 19.0204 | 19.2846 | 19.5487 | 19.8129 | 20.0771 | 20.3412 | 20.6054 | 20.8696 | 70 |
| 80 | 21.1338 | 21.3979 | 21.6621 | 21.9263 | 22.1904 | 22.4546 | 22.7188 | 22.9830 | 23.2471 | 23.5113 | 80 |
| 90 | 23.7755 | 24.0397 | 24.3038 | 24.5680 | 24.8322 | 25.0963 | 25.3605 | 25.6247 | 25.8889 | 26.1530 | 90 |
| 100 | 26.4172 | 26.6814 | 26.9455 | 27.2097 | 27.4739 | 27.7381 | 28.0022 | 28.2664 | 28.5306 | 28.7947 | 100 |

GALLONS (IMP.) TO LITERS

| Imp gal. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Imp gal. |
|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| | liters | liters | liters | liters | liters | liters | liters | liters | liters | liters | |
| — | — | 4.5459 | 9.0918 | 13.6377 | 18.1836 | 22.7295 | 27.2754 | 31.8213 | 36.3672 | 40.9131 | — |
| 10 | 45.4590 | 50.0049 | 54.5508 | 59.0967 | 63.6426 | 68.1885 | 72.7344 | 77.2803 | 81.8262 | 86.3721 | 10 |
| 20 | 90.9180 | 95.4639 | 100.0098 | 104.5557 | 109.1016 | 113.6475 | 118.1934 | 122.7393 | 127.2852 | 131.8311 | 20 |
| 30 | 136.3770 | 140.9229 | 145.4688 | 150.0147 | 154.5606 | 159.1065 | 163.6524 | 168.1983 | 172.7442 | 177.2901 | 30 |
| 40 | 181.8360 | 186.3819 | 190.9278 | 195.4737 | 200.0196 | 204.5655 | 209.1114 | 213.6573 | 218.2032 | 222.7491 | 40 |
| 50 | 227.2950 | 231.8409 | 236.3868 | 240.9327 | 245.4786 | 250.0245 | 254.5704 | 259.1163 | 263.6622 | 268.2081 | 50 |
| 60 | 272.7540 | 277.2999 | 281.8458 | 286.3917 | 290.9376 | 295.4835 | 300.0294 | 304.5753 | 309.1212 | 313.6671 | 60 |
| 70 | 318.2130 | 322.7589 | 327.3048 | 331.8507 | 336.3966 | 340.9425 | 345.4884 | 350.0343 | 354.5802 | 359.1261 | 70 |
| 80 | 363.6720 | 368.2179 | 372.7638 | 377.3097 | 381.8556 | 386.4015 | 390.9474 | 395.4933 | 400.0392 | 404.5851 | 80 |
| 90 | 409.1310 | 413.6769 | 418.2228 | 422.7687 | 427.3146 | 431.8605 | 436.4064 | 440.9523 | 445.4982 | 450.0441 | 90 |
| 100 | 454.5900 | 459.1359 | 463.6818 | 468.2277 | 472.7736 | 477.3195 | 481.8654 | 486.4113 | 490.9572 | 495.5031 | 100 |

LITERS TO GALLONS (IMP.)

| liters | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | liters |
|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------|
| | gal. | gal. | gal. | gal. | gal. | gal. | gal. | gal. | gal. | gal. | |
| — | — | 0.2200 | 0.4400 | 0.6599 | 0.8799 | 1.0999 | 1.3199 | 1.5399 | 1.7598 | 1.9798 | — |
| 10 | 2.1998 | 2.4198 | 2.6398 | 2.8597 | 3.0797 | 3.2997 | 3.5197 | 3.7397 | 3.9596 | 4.1796 | 10 |
| 20 | 4.3996 | 4.6196 | 4.8396 | 5.0595 | 5.2795 | 5.4995 | 5.7195 | 5.9395 | 6.1594 | 6.3794 | 20 |
| 30 | 6.5994 | 6.8194 | 7.0394 | 7.2593 | 7.4793 | 7.6993 | 7.9193 | 8.1393 | 8.3592 | 8.5792 | 30 |
| 40 | 8.7992 | 9.0192 | 9.2392 | 9.4591 | 9.6791 | 9.8991 | 10.1191 | 10.3391 | 10.5590 | 10.7790 | 40 |
| 50 | 10.9990 | 11.2190 | 11.4390 | 11.6589 | 11.8789 | 12.0989 | 12.3189 | 12.5389 | 12.7588 | 12.9788 | 50 |
| 60 | 13.1988 | 13.4188 | 13.6388 | 13.8587 | 14.0787 | 14.2987 | 14.5187 | 14.7387 | 14.9586 | 15.1786 | 60 |
| 70 | 15.3986 | 15.6186 | 15.8386 | 16.0585 | 16.2785 | 16.4985 | 16.7185 | 16.9385 | 17.1584 | 17.3784 | 70 |
| 80 | 17.5984 | 17.8184 | 18.0384 | 18.2583 | 18.4783 | 18.6983 | 18.9183 | 19.1383 | 19.3582 | 19.5782 | 80 |
| 90 | 19.7982 | 20.0182 | 20.2382 | 20.4581 | 20.6781 | 20.8981 | 21.1181 | 21.3381 | 21.5580 | 21.7780 | 90 |
| 100 | 21.9980 | 22.2180 | 22.4380 | 22.6579 | 22.8779 | 23.0979 | 23.3179 | 23.5379 | 23.7578 | 23.9778 | 100 |

MASS**POUNDS TO KILOGRAMS**

| lbs. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | lbs. |
|------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|------|
| | kg | kg | kg | kg | kg | kg | kg | kg | kg | kg | |
| — | — | 0.454 | 0.907 | 1.361 | 1.814 | 2.268 | 2.722 | 3.175 | 3.629 | 4.082 | — |
| 10 | 4.536 | 4.989 | 5.443 | 5.897 | 6.350 | 6.804 | 7.257 | 7.711 | 8.165 | 8.618 | 10 |
| 20 | 9.072 | 9.525 | 9.979 | 10.433 | 10.886 | 11.340 | 11.793 | 12.247 | 12.701 | 13.154 | 20 |
| 30 | 13.608 | 14.061 | 14.515 | 14.968 | 15.422 | 15.876 | 16.329 | 16.783 | 17.236 | 17.690 | 30 |
| 40 | 18.144 | 18.597 | 19.051 | 19.504 | 19.958 | 20.412 | 20.865 | 21.319 | 21.772 | 22.226 | 40 |
| 50 | 22.680 | 23.133 | 23.587 | 24.040 | 24.494 | 24.947 | 25.401 | 25.855 | 26.308 | 26.762 | 50 |
| 60 | 27.215 | 27.669 | 28.123 | 28.576 | 29.030 | 29.483 | 29.937 | 30.391 | 30.844 | 31.298 | 60 |
| 70 | 31.751 | 32.205 | 32.658 | 33.112 | 33.566 | 34.019 | 34.473 | 34.926 | 35.380 | 35.834 | 70 |
| 80 | 36.287 | 36.741 | 37.194 | 37.648 | 38.102 | 38.555 | 39.009 | 39.462 | 39.916 | 40.370 | 80 |
| 90 | 40.823 | 41.277 | 41.730 | 42.184 | 42.637 | 43.091 | 43.545 | 43.998 | 44.452 | 44.905 | 90 |
| 100 | 45.359 | 45.813 | 46.266 | 46.720 | 47.173 | 47.627 | 48.081 | 48.534 | 48.988 | 49.441 | 100 |

KILOGRAMS TO POUNDS

| kg | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | kg |
|-----|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|-----|
| | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | |
| — | — | 2.205 | 4.409 | 6.614 | 8.818 | 11.023 | 13.228 | 15.432 | 17.637 | 19.842 | — |
| 10 | 22.046 | 24.251 | 26.455 | 28.660 | 30.865 | 33.069 | 35.274 | 37.479 | 39.683 | 41.888 | 10 |
| 20 | 44.092 | 46.297 | 48.502 | 50.706 | 52.911 | 55.116 | 57.320 | 59.525 | 61.729 | 63.934 | 20 |
| 30 | 66.139 | 68.343 | 70.548 | 72.752 | 74.957 | 77.162 | 79.366 | 81.571 | 83.776 | 85.980 | 30 |
| 40 | 88.185 | 90.389 | 92.594 | 94.799 | 97.003 | 99.208 | 101.413 | 103.617 | 105.822 | 108.026 | 40 |
| 50 | 110.231 | 112.436 | 114.640 | 116.845 | 119.049 | 121.254 | 123.459 | 125.663 | 127.868 | 130.073 | 50 |
| 60 | 132.277 | 134.482 | 136.686 | 138.891 | 141.096 | 143.300 | 145.505 | 147.710 | 149.914 | 152.119 | 60 |
| 70 | 154.323 | 156.528 | 158.733 | 160.937 | 163.142 | 165.347 | 167.551 | 169.756 | 171.960 | 174.165 | 70 |
| 80 | 176.370 | 178.574 | 180.779 | 182.983 | 185.188 | 187.393 | 189.597 | 191.802 | 194.007 | 196.211 | 80 |
| 90 | 198.416 | 200.620 | 202.825 | 205.030 | 207.234 | 209.439 | 211.644 | 213.848 | 216.053 | 218.257 | 90 |
| 100 | 220.462 | 222.667 | 224.871 | 227.076 | 229.280 | 231.485 | 233.690 | 235.894 | 238.099 | 240.304 | 100 |

KILOGRAMS TO NEWTON

| kg | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | kg |
|-----|--------|--------|---------|---------|---------|---------|---------|---------|---------|---------|-----|
| | N | N | N | N | N | N | N | N | N | N | |
| — | — | 9.81 | 19.61 | 29.42 | 39.23 | 49.03 | 58.84 | 68.65 | 78.45 | 88.26 | — |
| 10 | 98.07 | 107.87 | 117.68 | 127.49 | 137.29 | 147.10 | 156.91 | 166.71 | 176.52 | 186.33 | 10 |
| 20 | 196.13 | 205.94 | 215.75 | 225.55 | 235.36 | 245.17 | 254.97 | 264.78 | 274.59 | 284.39 | 20 |
| 30 | 294.20 | 304.01 | 313.81 | 323.62 | 333.43 | 343.23 | 353.04 | 362.85 | 372.65 | 382.46 | 30 |
| 40 | 392.27 | 402.07 | 411.88 | 421.69 | 431.49 | 441.30 | 451.11 | 460.91 | 470.72 | 480.53 | 40 |
| 50 | 490.34 | 500.14 | 509.95 | 519.76 | 529.56 | 539.37 | 549.18 | 558.98 | 568.79 | 578.60 | 50 |
| 60 | 588.40 | 598.21 | 608.02 | 617.82 | 627.63 | 637.44 | 647.24 | 657.05 | 666.86 | 676.66 | 60 |
| 70 | 686.47 | 696.28 | 706.08 | 715.89 | 725.70 | 735.50 | 745.31 | 755.12 | 764.92 | 774.73 | 70 |
| 80 | 784.54 | 794.34 | 804.15 | 813.96 | 823.76 | 833.57 | 843.38 | 853.18 | 862.99 | 872.80 | 80 |
| 90 | 882.60 | 892.41 | 902.22 | 912.02 | 921.83 | 931.64 | 941.44 | 951.25 | 961.06 | 970.86 | 90 |
| 100 | 980.67 | 990.48 | 1000.28 | 1010.09 | 1019.90 | 1029.70 | 1039.51 | 1049.32 | 1059.12 | 1068.93 | 100 |

NEWTON TO KILOGRAMS

| N | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | N |
|------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|------|
| | kg | kg | kg | kg | kg | kg | kg | kg | kg | kg | |
| — | — | 1.020 | 2.039 | 3.059 | 4.079 | 5.099 | 6.118 | 7.138 | 8.158 | 9.177 | — |
| 100 | 10.197 | 11.217 | 12.237 | 13.256 | 14.276 | 15.296 | 16.316 | 17.335 | 18.355 | 19.375 | 100 |
| 200 | 20.394 | 21.414 | 22.434 | 23.454 | 24.473 | 25.493 | 26.513 | 27.532 | 28.552 | 29.572 | 200 |
| 300 | 30.592 | 31.611 | 32.631 | 33.651 | 34.670 | 35.690 | 36.710 | 37.730 | 38.749 | 39.769 | 300 |
| 400 | 40.789 | 41.809 | 42.828 | 43.848 | 44.868 | 45.887 | 46.907 | 47.927 | 48.947 | 49.966 | 400 |
| 500 | 50.986 | 52.006 | 53.025 | 54.045 | 55.065 | 56.085 | 57.104 | 58.124 | 59.144 | 60.163 | 500 |
| 600 | 61.183 | 62.203 | 63.223 | 64.242 | 65.262 | 66.282 | 67.302 | 68.321 | 69.341 | 70.361 | 600 |
| 700 | 71.380 | 72.400 | 73.420 | 74.440 | 75.459 | 76.479 | 77.499 | 78.518 | 79.538 | 80.558 | 700 |
| 800 | 81.578 | 82.597 | 83.617 | 84.637 | 85.656 | 86.676 | 87.696 | 88.716 | 89.735 | 90.755 | 800 |
| 900 | 91.775 | 92.795 | 93.814 | 94.834 | 95.854 | 96.873 | 97.893 | 98.913 | 99.933 | 100.952 | 900 |
| 1000 | 101.972 | 102.992 | 104.011 | 105.031 | 106.051 | 107.071 | 108.090 | 109.110 | 110.130 | 111.149 | 1000 |

118 CONVERSION TABLE

PRESSURE

POUNDS PER SQUARE INCHES TO KILOGRAMS PER SQUARE CENTIMETERS

| lb/in ² | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | lb/in ² |
|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|
| (psi) | kg/cm ² | kg/cm ² | kg/cm ² | kg/cm ² | kg/cm ² | kg/cm ² | kg/cm ² | kg/cm ² | kg/cm ² | kg/cm ² | (psi) |
| — | — | 0.0703 | 0.1406 | 0.2109 | 0.2812 | 0.3515 | 0.4218 | 0.4921 | 0.5625 | 0.6328 | — |
| 10 | 0.7031 | 0.7734 | 0.8437 | 0.9140 | 0.9843 | 1.0546 | 1.1249 | 1.1952 | 1.2655 | 1.3358 | 10 |
| 20 | 1.4061 | 1.4764 | 1.5468 | 1.6171 | 1.6874 | 1.7577 | 1.8280 | 1.8983 | 1.9686 | 2.0389 | 20 |
| 30 | 2.1092 | 2.1795 | 2.2498 | 2.3201 | 2.3904 | 2.4607 | 2.5311 | 2.6014 | 2.6717 | 2.7420 | 30 |
| 40 | 2.8123 | 2.8826 | 2.9529 | 3.0232 | 3.0935 | 3.1638 | 3.2341 | 3.3044 | 3.3747 | 3.4450 | 40 |
| 50 | 3.5154 | 3.5857 | 3.6560 | 3.7263 | 3.7966 | 3.8669 | 3.9372 | 4.0075 | 4.0778 | 4.1481 | 50 |
| 60 | 4.2184 | 4.2887 | 4.3590 | 4.4293 | 4.4996 | 4.5700 | 4.6403 | 4.7106 | 4.7809 | 4.8512 | 60 |
| 70 | 4.9215 | 4.9918 | 5.0621 | 5.1324 | 5.2027 | 5.2730 | 5.3433 | 5.4136 | 5.4839 | 5.5543 | 70 |
| 80 | 5.6246 | 5.6949 | 5.7652 | 5.8355 | 5.9058 | 5.9761 | 6.0464 | 6.1167 | 6.1870 | 6.2573 | 80 |
| 90 | 6.3276 | 6.3979 | 6.4682 | 6.5386 | 6.6089 | 6.6792 | 6.7495 | 6.8198 | 6.8901 | 6.9604 | 90 |
| 100 | 7.0307 | 7.1010 | 7.1713 | 7.2416 | 7.3119 | 7.3822 | 7.4525 | 7.5228 | 7.5932 | 7.6635 | 100 |

KILOGRAMS PER SQUARE CENTIMETERS TO POUNDS PER SQUARE INCHES

| kg/cm ² | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | kg/cm ² |
|--------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------|
| | lb/in ² (psi) | lb/in ² (psi) | lb/in ² (psi) | lb/in ² (psi) | lb/in ² (psi) | lb/in ² (psi) | lb/in ² (psi) | lb/in ² (psi) | lb/in ² (psi) | lb/in ² (psi) | |
| — | — | 14.22 | 28.45 | 42.67 | 56.89 | 71.12 | 85.34 | 99.56 | 113.78 | 128.01 | — |
| 10 | 142.23 | 156.45 | 170.68 | 184.90 | 199.12 | 213.35 | 227.57 | 241.79 | 256.01 | 270.24 | 10 |
| 20 | 284.46 | 298.68 | 312.91 | 327.13 | 341.35 | 355.58 | 369.80 | 384.02 | 398.24 | 412.47 | 20 |
| 30 | 426.69 | 440.91 | 455.14 | 469.36 | 483.58 | 497.81 | 512.03 | 526.25 | 540.47 | 554.70 | 30 |
| 40 | 568.92 | 583.14 | 597.37 | 611.59 | 625.81 | 640.04 | 654.26 | 668.48 | 682.70 | 696.93 | 40 |
| 50 | 711.15 | 725.37 | 739.60 | 753.82 | 768.04 | 782.27 | 796.49 | 810.71 | 824.93 | 839.16 | 50 |
| 60 | 853.38 | 867.60 | 881.83 | 896.05 | 910.27 | 924.50 | 938.72 | 952.94 | 967.16 | 981.39 | 60 |
| 70 | 995.61 | 1009.83 | 1024.06 | 1038.28 | 1052.50 | 1066.73 | 1080.95 | 1095.17 | 1109.39 | 1123.62 | 70 |
| 80 | 1137.84 | 1152.06 | 1166.29 | 1180.51 | 1194.73 | 1208.96 | 1223.18 | 1237.40 | 1251.62 | 1265.85 | 80 |
| 90 | 1280.07 | 1294.29 | 1308.52 | 1322.74 | 1336.96 | 1351.19 | 1365.41 | 1379.63 | 1393.85 | 1408.08 | 90 |
| 100 | 1422.30 | 1436.52 | 1450.75 | 1464.97 | 1479.19 | 1493.42 | 1507.64 | 1521.86 | 1536.08 | 1550.31 | 100 |

KILOGRAMS PER SQUARE CENTIMETERS TO KILO PASCAL

| kg/cm ² | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | kg/cm ² |
|--------------------|--------|--------|---------|---------|---------|---------|---------|---------|---------|---------|--------------------|
| | KPa | KPa | KPa | KPa | KPa | KPa | KPa | KPa | KPa | KPa | |
| — | — | 98.1 | 196.1 | 294.2 | 392.3 | 490.3 | 588.4 | 686.5 | 784.5 | 882.6 | — |
| 10 | 980.7 | 1078.7 | 1176.8 | 1274.9 | 1372.9 | 1471.0 | 1569.1 | 1667.1 | 1765.2 | 1863.3 | 10 |
| 20 | 1961.3 | 2059.4 | 2157.5 | 2255.5 | 2353.6 | 2451.7 | 2549.7 | 2647.8 | 2745.9 | 2843.9 | 20 |
| 30 | 2942.0 | 3040.1 | 3138.1 | 3236.2 | 3334.3 | 3432.3 | 3530.4 | 3628.5 | 3726.5 | 3824.6 | 30 |
| 40 | 3922.7 | 4020.7 | 4118.8 | 4216.9 | 4314.9 | 4413.0 | 4511.1 | 4609.1 | 4707.2 | 4805.3 | 40 |
| 50 | 4903.4 | 5001.4 | 5099.5 | 5197.6 | 5295.6 | 5393.7 | 5491.8 | 5589.8 | 5687.9 | 5786.0 | 50 |
| 60 | 5884.0 | 5982.1 | 6080.2 | 6178.2 | 6276.3 | 6374.4 | 6472.4 | 6570.5 | 6668.6 | 6766.6 | 60 |
| 70 | 6864.7 | 6962.8 | 7060.8 | 7158.9 | 7257.0 | 7355.0 | 7453.1 | 7551.2 | 7649.2 | 7747.3 | 70 |
| 80 | 7845.4 | 7943.4 | 8041.5 | 8139.6 | 8237.6 | 8335.7 | 8433.8 | 8531.8 | 8629.9 | 8728.0 | 80 |
| 90 | 8826.0 | 8924.1 | 9022.2 | 9120.2 | 9218.3 | 9316.4 | 9414.4 | 9512.5 | 9610.6 | 9708.6 | 90 |
| 100 | 9806.7 | 9904.8 | 10002.8 | 10100.9 | 10199.0 | 10297.0 | 10395.1 | 10493.2 | 10591.2 | 10689.3 | 100 |

KILO PASCAL TO KILOGRAMS PER SQUARE CENTIMETERS

| KPa | 0 | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 | KPa |
|-------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|-------|
| | kg/cm ² | kg/cm ² | kg/cm ² | kg/cm ² | kg/cm ² | kg/cm ² | kg/cm ² | kg/cm ² | kg/cm ² | kg/cm ² | |
| — | — | 1.020 | 2.039 | 3.059 | 4.079 | 5.099 | 6.118 | 7.138 | 8.158 | 9.177 | — |
| 1000 | 10.197 | 11.217 | 12.237 | 13.256 | 14.276 | 15.296 | 16.316 | 17.335 | 18.355 | 19.375 | 1000 |
| 2000 | 20.394 | 21.414 | 22.434 | 23.454 | 24.473 | 25.493 | 26.513 | 27.532 | 28.552 | 29.572 | 2000 |
| 3000 | 30.592 | 31.611 | 32.631 | 33.651 | 34.670 | 35.690 | 36.710 | 37.730 | 38.749 | 39.769 | 3000 |
| 4000 | 40.789 | 41.809 | 42.828 | 43.848 | 44.868 | 45.887 | 46.907 | 47.927 | 48.947 | 49.966 | 4000 |
| 5000 | 50.986 | 52.006 | 53.025 | 54.045 | 55.065 | 56.085 | 57.104 | 58.124 | 59.144 | 60.163 | 5000 |
| 6000 | 61.183 | 62.203 | 63.223 | 64.242 | 65.262 | 66.282 | 67.302 | 68.321 | 69.341 | 70.361 | 6000 |
| 7000 | 71.380 | 72.400 | 73.420 | 74.440 | 75.459 | 76.479 | 77.499 | 78.518 | 79.538 | 80.558 | 7000 |
| 8000 | 81.578 | 82.597 | 83.617 | 84.637 | 85.656 | 86.676 | 87.696 | 88.716 | 89.735 | 90.755 | 8000 |
| 9000 | 91.775 | 92.795 | 93.814 | 94.834 | 95.854 | 96.873 | 97.893 | 98.913 | 99.933 | 100.952 | 9000 |
| 10000 | 101.972 | 102.992 | 104.011 | 105.031 | 106.051 | 107.071 | 108.090 | 109.110 | 110.130 | 111.149 | 10000 |

TORQUE**FOOT POUNDS TO KILOGRAMMETERS**

| ft. lbs. | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | ft. lbs. |
|----------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|----------|
| | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | |
| — | — | 0.138 | 0.277 | 0.415 | 0.553 | 0.691 | 0.830 | 0.968 | 1.106 | 1.244 | — |
| 10 | 1.383 | 1.521 | 1.659 | 1.797 | 1.936 | 2.074 | 2.212 | 2.350 | 2.489 | 2.627 | 10 |
| 20 | 2.765 | 2.903 | 3.042 | 3.180 | 3.318 | 3.457 | 3.595 | 3.733 | 3.871 | 4.010 | 20 |
| 30 | 4.148 | 4.286 | 4.424 | 4.563 | 4.701 | 4.839 | 4.977 | 5.116 | 5.254 | 5.392 | 30 |
| 40 | 5.530 | 5.669 | 5.807 | 5.945 | 6.083 | 6.222 | 6.360 | 6.498 | 6.636 | 6.775 | 40 |
| 50 | 6.913 | 7.051 | 7.190 | 7.328 | 7.466 | 7.604 | 7.743 | 7.881 | 8.019 | 8.157 | 50 |
| 60 | 8.296 | 8.434 | 8.572 | 8.710 | 8.849 | 8.987 | 9.125 | 9.263 | 9.402 | 9.540 | 60 |
| 70 | 9.678 | 9.816 | 9.955 | 10.093 | 10.231 | 10.370 | 10.508 | 10.646 | 10.784 | 10.923 | 70 |
| 80 | 11.061 | 11.199 | 11.337 | 11.476 | 11.614 | 11.752 | 11.890 | 12.029 | 12.167 | 12.305 | 80 |
| 90 | 12.443 | 12.582 | 12.720 | 12.858 | 12.996 | 13.135 | 13.273 | 13.411 | 13.549 | 13.688 | 90 |
| 100 | 13.826 | 13.964 | 14.103 | 14.241 | 14.379 | 14.517 | 14.656 | 14.794 | 14.932 | 15.070 | 100 |

KILOGRAMMETERS TO FOOT POUNDS

| kg-m | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | kg-m |
|------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|------|
| | ft. lbs. | ft. lbs. | ft. lbs. | ft. lbs. | ft. lbs. | ft. lbs. | ft. lbs. | ft. lbs. | ft. lbs. | ft. lbs. | |
| — | — | 7.23 | 14.47 | 21.70 | 28.93 | 36.17 | 43.40 | 50.63 | 57.86 | 65.10 | — |
| 10 | 72.33 | 79.56 | 86.80 | 94.03 | 101.26 | 108.50 | 115.73 | 122.96 | 130.19 | 137.43 | 10 |
| 20 | 144.66 | 151.89 | 159.13 | 166.36 | 173.59 | 180.83 | 188.06 | 195.29 | 202.52 | 209.76 | 20 |
| 30 | 216.99 | 224.22 | 231.46 | 238.69 | 245.92 | 253.16 | 260.39 | 267.62 | 274.85 | 282.09 | 30 |
| 40 | 289.32 | 296.55 | 303.79 | 311.02 | 318.25 | 325.49 | 332.72 | 339.95 | 347.18 | 354.42 | 40 |
| 50 | 361.65 | 368.88 | 376.12 | 383.35 | 390.58 | 397.82 | 405.05 | 412.28 | 419.51 | 426.75 | 50 |
| 60 | 433.98 | 441.21 | 448.45 | 455.68 | 462.91 | 470.15 | 477.38 | 484.61 | 491.84 | 499.08 | 60 |
| 70 | 506.31 | 513.54 | 520.78 | 528.01 | 535.24 | 542.48 | 549.71 | 556.94 | 564.17 | 571.41 | 70 |
| 80 | 578.64 | 585.87 | 593.11 | 600.34 | 607.57 | 614.81 | 622.04 | 629.27 | 636.50 | 643.74 | 80 |
| 90 | 650.97 | 658.20 | 665.44 | 672.67 | 679.90 | 687.14 | 694.37 | 701.60 | 708.83 | 716.07 | 90 |
| 100 | 723.30 | 730.53 | 737.77 | 745.00 | 752.23 | 759.47 | 766.70 | 773.93 | 781.16 | 788.40 | 100 |

KILOGRAMMETERS TO NEWTONMETERS

| kg-m | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | kg-m |
|------|--------|--------|---------|---------|---------|---------|---------|---------|---------|---------|------|
| | N-m | N-m | N-m | N-m | N-m | N-m | N-m | N-m | N-m | N-m | |
| — | — | 9.81 | 19.61 | 29.42 | 39.23 | 49.03 | 58.84 | 68.65 | 78.45 | 88.26 | — |
| 10 | 98.07 | 107.87 | 117.68 | 127.49 | 137.29 | 147.10 | 156.91 | 166.71 | 176.52 | 186.33 | 10 |
| 20 | 196.13 | 205.94 | 215.75 | 225.55 | 235.36 | 245.17 | 254.97 | 264.78 | 274.59 | 284.39 | 20 |
| 30 | 294.20 | 304.01 | 313.81 | 323.62 | 333.43 | 343.23 | 353.04 | 362.85 | 372.65 | 382.46 | 30 |
| 40 | 392.27 | 402.07 | 411.88 | 421.69 | 431.49 | 441.30 | 451.11 | 460.91 | 470.72 | 480.53 | 40 |
| 50 | 490.34 | 500.14 | 509.95 | 519.76 | 529.56 | 539.37 | 549.18 | 558.98 | 568.79 | 578.60 | 50 |
| 60 | 588.40 | 598.21 | 608.02 | 617.82 | 627.63 | 637.44 | 647.24 | 657.05 | 666.86 | 676.66 | 60 |
| 70 | 686.47 | 696.28 | 706.08 | 715.89 | 725.70 | 735.50 | 745.31 | 755.12 | 764.92 | 774.73 | 70 |
| 80 | 784.54 | 794.34 | 804.15 | 813.96 | 823.76 | 833.57 | 843.38 | 853.18 | 862.99 | 872.80 | 80 |
| 90 | 882.60 | 892.41 | 902.22 | 912.02 | 921.83 | 931.64 | 941.44 | 951.25 | 961.06 | 970.86 | 90 |
| 100 | 980.67 | 990.48 | 1000.28 | 1010.09 | 1019.90 | 1029.70 | 1039.51 | 1049.32 | 1059.12 | 1068.93 | 100 |

NEWTONMETERS TO KILOGRAMMETERS

| N-m | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | N-m |
|------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|------|
| | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | kg-m | |
| — | — | 1.020 | 2.039 | 3.059 | 4.079 | 5.099 | 6.118 | 7.138 | 8.158 | 9.177 | — |
| 100 | 10.197 | 11.217 | 12.236 | 13.256 | 14.276 | 15.296 | 16.315 | 17.335 | 18.355 | 19.374 | 100 |
| 200 | 20.394 | 21.414 | 22.433 | 23.453 | 24.473 | 25.493 | 26.512 | 27.532 | 28.552 | 29.571 | 200 |
| 300 | 30.591 | 31.611 | 32.630 | 33.650 | 34.670 | 35.690 | 36.709 | 37.729 | 38.749 | 39.768 | 300 |
| 400 | 40.788 | 41.808 | 42.827 | 43.847 | 44.867 | 45.887 | 46.906 | 47.926 | 48.946 | 49.965 | 400 |
| 500 | 50.985 | 52.005 | 53.024 | 54.044 | 55.064 | 56.084 | 57.103 | 58.123 | 59.143 | 60.162 | 500 |
| 600 | 61.182 | 62.202 | 63.221 | 64.241 | 65.261 | 66.281 | 67.300 | 68.320 | 69.340 | 70.359 | 600 |
| 700 | 71.379 | 72.399 | 73.418 | 74.438 | 75.458 | 76.478 | 77.497 | 78.517 | 79.537 | 80.556 | 700 |
| 800 | 81.576 | 82.596 | 83.615 | 84.635 | 85.655 | 86.675 | 87.694 | 88.714 | 89.734 | 90.753 | 800 |
| 900 | 91.773 | 92.793 | 93.812 | 94.832 | 95.852 | 96.872 | 97.891 | 98.911 | 99.931 | 100.950 | 900 |
| 1000 | 101.970 | 102.990 | 104.009 | 105.029 | 106.049 | 107.069 | 108.088 | 109.108 | 110.128 | 111.147 | 1000 |

120 CONVERSION TABLE

TEMPERATURE

FAHRENHEIT TO CENTIGRADE

| °F | °C | °F | °C | °F | °C | °F | °C | °F | °C | °F | °C | °F | °C | °F | °C |
|-----|-------|----|-------|-----|------|-----|------|-----|-------|-----|-------|-----|-------|-----|-------|
| -60 | -51.1 | -2 | -18.9 | 56 | 13.3 | 114 | 45.6 | 172 | 77.8 | 230 | 110.0 | 288 | 142.2 | 346 | 174.4 |
| -58 | -50.0 | 0 | -17.8 | 58 | 14.4 | 116 | 46.7 | 174 | 78.9 | 232 | 111.1 | 290 | 143.3 | 348 | 175.6 |
| -56 | -48.9 | 2 | -16.7 | 60 | 15.6 | 118 | 47.8 | 176 | 80.0 | 234 | 112.2 | 292 | 144.4 | 350 | 176.7 |
| -54 | -47.8 | 4 | -15.6 | 62 | 16.7 | 120 | 48.9 | 178 | 81.1 | 236 | 113.3 | 294 | 145.6 | 352 | 177.8 |
| -52 | -46.7 | 6 | -14.4 | 64 | 17.8 | 122 | 50.0 | 180 | 82.2 | 238 | 114.4 | 296 | 146.7 | 354 | 178.9 |
| -50 | -45.6 | 8 | -13.3 | 66 | 18.9 | 124 | 51.1 | 182 | 83.3 | 240 | 115.6 | 298 | 147.8 | 356 | 180.0 |
| -48 | -44.4 | 10 | -12.2 | 68 | 20.0 | 126 | 52.2 | 184 | 84.4 | 242 | 116.7 | 300 | 148.9 | 358 | 181.1 |
| -46 | -43.3 | 12 | -11.1 | 70 | 21.1 | 128 | 53.3 | 186 | 85.6 | 244 | 117.8 | 302 | 150.0 | 360 | 182.2 |
| -44 | -42.2 | 14 | -10.0 | 72 | 22.2 | 130 | 54.4 | 188 | 86.7 | 246 | 118.9 | 304 | 151.1 | 362 | 183.3 |
| -42 | -41.1 | 16 | -8.9 | 74 | 23.3 | 132 | 55.6 | 190 | 87.8 | 248 | 120.0 | 306 | 152.2 | 364 | 184.4 |
| -40 | -40.0 | 18 | -7.8 | 76 | 24.4 | 134 | 56.7 | 192 | 88.9 | 250 | 121.1 | 308 | 153.3 | 366 | 185.6 |
| -38 | -38.9 | 20 | -6.7 | 78 | 25.6 | 136 | 57.8 | 194 | 90.0 | 252 | 122.2 | 310 | 154.4 | 368 | 186.7 |
| -36 | -37.8 | 22 | -5.6 | 80 | 26.7 | 138 | 58.9 | 196 | 91.1 | 254 | 123.3 | 312 | 155.6 | 370 | 187.8 |
| -34 | -36.7 | 24 | -4.4 | 82 | 27.8 | 140 | 60.0 | 198 | 92.2 | 256 | 124.4 | 314 | 156.7 | 372 | 188.9 |
| -32 | -35.6 | 26 | -3.3 | 84 | 28.9 | 142 | 61.1 | 200 | 93.3 | 258 | 125.6 | 316 | 157.8 | 374 | 190.0 |
| -30 | -34.4 | 28 | -2.2 | 86 | 30.0 | 144 | 62.2 | 202 | 94.4 | 260 | 126.7 | 318 | 158.9 | 376 | 191.1 |
| -28 | -33.3 | 30 | -1.1 | 88 | 31.1 | 146 | 63.3 | 204 | 95.6 | 262 | 127.8 | 320 | 160.0 | 378 | 192.2 |
| -26 | -32.2 | 32 | 0.0 | 90 | 32.2 | 148 | 64.4 | 206 | 96.7 | 264 | 128.9 | 322 | 161.1 | 380 | 193.3 |
| -24 | -31.1 | 34 | 1.1 | 92 | 33.3 | 150 | 65.6 | 208 | 97.8 | 266 | 130.0 | 324 | 162.2 | 382 | 194.4 |
| -22 | -30.0 | 36 | 2.2 | 94 | 34.4 | 152 | 66.7 | 210 | 98.9 | 268 | 131.1 | 326 | 163.3 | 384 | 195.6 |
| -20 | -28.9 | 38 | 3.3 | 96 | 35.6 | 154 | 67.8 | 212 | 100.0 | 270 | 132.2 | 328 | 164.4 | 386 | 196.7 |
| -18 | -27.8 | 40 | 4.4 | 98 | 36.7 | 156 | 68.9 | 214 | 101.1 | 272 | 133.3 | 330 | 165.6 | 388 | 197.8 |
| -16 | -26.7 | 42 | 5.6 | 100 | 37.8 | 158 | 70.0 | 216 | 102.2 | 274 | 134.4 | 332 | 166.7 | 390 | 198.9 |
| -14 | -25.6 | 44 | 6.7 | 102 | 38.9 | 160 | 71.1 | 218 | 103.3 | 276 | 135.6 | 334 | 167.8 | 392 | 200.0 |
| -12 | -24.4 | 46 | 7.8 | 104 | 40.0 | 162 | 72.2 | 220 | 104.4 | 278 | 136.7 | 336 | 168.9 | 400 | 204.4 |
| -10 | -23.3 | 48 | 8.9 | 106 | 41.1 | 164 | 73.3 | 222 | 105.6 | 280 | 137.8 | 338 | 170.0 | 410 | 210.0 |
| -8 | -22.2 | 50 | 10.0 | 108 | 42.2 | 166 | 74.4 | 224 | 106.7 | 282 | 138.9 | 340 | 171.1 | 420 | 215.6 |
| -6 | -21.1 | 52 | 11.1 | 110 | 43.3 | 168 | 75.6 | 226 | 107.8 | 284 | 140.0 | 342 | 172.2 | 430 | 221.1 |
| -4 | -20.0 | 54 | 12.2 | 112 | 44.4 | 170 | 76.7 | 228 | 108.9 | 286 | 141.1 | 344 | 173.3 | 440 | 226.7 |

CENTIGRADE TO FAHRENHEIT

| °C | °F | °C | °F | °C | °F | °C | °F | °C | °F | °C | °F | °C | °F | °C | °F |
|-----|-------|-----|------|----|-------|----|-------|-----|-------|-----|-------|-----|-------|-----|-------|
| -50 | -58.0 | -18 | -0.4 | 14 | 57.2 | 46 | 114.8 | 78 | 172.4 | 110 | 230.0 | 142 | 287.6 | 174 | 345.2 |
| -49 | -56.2 | -17 | 1.4 | 15 | 59.0 | 47 | 116.6 | 79 | 174.2 | 111 | 231.8 | 143 | 289.4 | 175 | 347.0 |
| -48 | -54.4 | -16 | 3.2 | 16 | 60.8 | 48 | 118.4 | 80 | 176.0 | 112 | 233.6 | 144 | 291.2 | 176 | 348.8 |
| -47 | -52.6 | -15 | 5.0 | 17 | 62.6 | 49 | 120.2 | 81 | 177.8 | 113 | 235.4 | 145 | 293.0 | 177 | 350.6 |
| -46 | -50.8 | -14 | 6.8 | 18 | 64.4 | 50 | 122.0 | 82 | 179.6 | 114 | 237.2 | 146 | 294.8 | 178 | 352.4 |
| -45 | -49.0 | -13 | 8.6 | 19 | 66.2 | 51 | 123.8 | 83 | 181.4 | 115 | 239.0 | 147 | 296.6 | 179 | 354.2 |
| -44 | -47.2 | -12 | 10.4 | 20 | 68.0 | 52 | 125.6 | 84 | 183.2 | 116 | 240.8 | 148 | 298.4 | 180 | 356.0 |
| -43 | -45.4 | -11 | 12.2 | 21 | 69.8 | 53 | 127.4 | 85 | 185.0 | 117 | 242.6 | 149 | 300.2 | 181 | 357.8 |
| -42 | -43.6 | -10 | 14.0 | 22 | 71.6 | 54 | 129.2 | 86 | 186.8 | 118 | 244.4 | 150 | 302.0 | 182 | 359.6 |
| -41 | -41.8 | -9 | 15.8 | 23 | 73.4 | 55 | 131.0 | 87 | 188.6 | 119 | 246.2 | 151 | 303.8 | 183 | 361.4 |
| -40 | -40.0 | -8 | 17.6 | 24 | 75.2 | 56 | 132.8 | 88 | 190.4 | 120 | 248.0 | 152 | 305.6 | 184 | 363.2 |
| -39 | -38.2 | -7 | 19.4 | 25 | 77.0 | 57 | 134.6 | 89 | 192.2 | 121 | 249.8 | 153 | 307.4 | 185 | 365.0 |
| -38 | -36.4 | -6 | 21.2 | 26 | 78.8 | 58 | 136.4 | 90 | 194.0 | 122 | 251.6 | 154 | 309.2 | 186 | 366.8 |
| -37 | -34.6 | -5 | 23.0 | 27 | 80.6 | 59 | 138.2 | 91 | 195.8 | 123 | 253.4 | 155 | 311.0 | 187 | 368.6 |
| -36 | -32.8 | -4 | 24.8 | 28 | 82.4 | 60 | 140.0 | 92 | 197.6 | 124 | 255.2 | 156 | 312.8 | 188 | 370.4 |
| -35 | -31.0 | -3 | 26.6 | 29 | 84.2 | 61 | 141.8 | 93 | 199.4 | 125 | 257.0 | 157 | 314.6 | 189 | 372.2 |
| -34 | -29.2 | -2 | 28.4 | 30 | 86.0 | 62 | 143.6 | 94 | 201.2 | 126 | 258.8 | 158 | 316.4 | 190 | 374.0 |
| -33 | -27.4 | -1 | 30.2 | 31 | 87.8 | 63 | 145.4 | 95 | 203.0 | 127 | 260.6 | 159 | 318.2 | 191 | 375.8 |
| -32 | -25.6 | 0 | 32.0 | 32 | 89.6 | 64 | 147.2 | 96 | 204.8 | 128 | 262.4 | 160 | 320.0 | 192 | 377.6 |
| -31 | -23.8 | 1 | 33.8 | 33 | 91.4 | 65 | 149.0 | 97 | 206.6 | 129 | 264.2 | 161 | 321.8 | 193 | 379.4 |
| -30 | -22.0 | 2 | 35.6 | 34 | 93.2 | 66 | 150.8 | 98 | 208.4 | 130 | 266.0 | 162 | 323.6 | 194 | 381.2 |
| -29 | -20.2 | 3 | 37.4 | 35 | 95.0 | 67 | 152.6 | 99 | 210.2 | 131 | 267.8 | 163 | 325.4 | 195 | 383.0 |
| -28 | -18.4 | 4 | 39.2 | 36 | 96.8 | 68 | 154.4 | 100 | 212.0 | 132 | 269.6 | 164 | 327.2 | 196 | 384.8 |
| -27 | -16.6 | 5 | 41.0 | 37 | 98.6 | 69 | 156.2 | 101 | 213.8 | 133 | 271.4 | 165 | 329.0 | 197 | 386.6 |
| -26 | -14.8 | 6 | 42.8 | 38 | 100.4 | 70 | 158.0 | 102 | 215.6 | 134 | 273.2 | 166 | 330.8 | 198 | 388.4 |
| -25 | -13.0 | 7 | 44.6 | 39 | 102.2 | 71 | 159.8 | 103 | 217.4 | 135 | 275.0 | 167 | 332.6 | 199 | 390.2 |
| -24 | -11.2 | 8 | 46.4 | 40 | 104.0 | 72 | 161.6 | 104 | 219.2 | 136 | 276.8 | 168 | 334.4 | 200 | 392.0 |
| -23 | -9.4 | 9 | 48.2 | 41 | 105.8 | 73 | 163.4 | 105 | 221.0 | 137 | 278.6 | 169 | 336.2 | 210 | 410.0 |
| -22 | -7.6 | 10 | 50.0 | 42 | 107.6 | 74 | 165.2 | 106 | 222.8 | 138 | 280.4 | 170 | 338.0 | 220 | 428.0 |
| -21 | -5.8 | 11 | 51.8 | 43 | 109.4 | 75 | 167.0 | 107 | 224.6 | 139 | 282.2 | 171 | 339.8 | 230 | 446.0 |
| -20 | -4.0 | 12 | 53.6 | 44 | 111.2 | 76 | 168.8 | 108 | 226.4 | 140 | 284.0 | 172 | 341.6 | 240 | 464.0 |
| -19 | -2.2 | 13 | 55.4 | 45 | 113.0 | 77 | 170.6 | 109 | 228.2 | 141 | 285.8 | 173 | 343.4 | 250 | 482.0 |

MEMO

This image shows a full page of a handwriting practice worksheet. It consists of multiple rows of horizontal dashed lines spaced evenly apart, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text on the page.

MEMO

[illegible]

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3LA1, 3LB1, 3LD1

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